Book of Abstracts

Bucharest

RAAD 2015

24th International Conference on Robotics in Alpe-Adria-Danube Region

27/28/29 May, 2015

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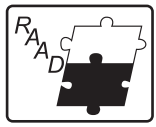

24th International Conference on Robotics in Alpe-Adria-Danube Region

27/28/29 May, 2015

University „Politehnica“ of Bucharest, Romania

Centre of Research in Computer Integrated Manufacturing and Robotics – CIMR, Bucharest, Romania

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Preprints of the International Conference RAAD 2015

ROBOTICS
IN ALPE-ADRIA-DANUBE REGION

May 27-29, 2015
Bucharest, Romania

Editors:
Theodor Borangiu, PhD
Iulia Voinescu, PhD

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Preface

The 24th International Conference on Robotics in Alpe-Adria-Danube Region, RAAD 2015, is held in Conference Centre of the Grand Hotel Continental, Bucharest, Romania, on May 27-29, 2015. The Conference brings together academic and industry researchers in robotics from the 11 Alpe-Adria-Danube Region affiliated countries (Austria, Croatia, Czech Republic, Germany, Greece, Hungary, Italy, Romania, Serbia, Slovakia and Slovenia), and their worldwide partners in a collegial and stimulating environment.

According to its tradition, RAAD 2015 covers all major areas of R&D and innovation in robotics, including new research trends such as: bio-inspired and cognitive robots, visual servoing of robot motion, human-robot interaction, and personal robots for ambient assisted living.

Papers were solicited on topics related to new theories, advanced design of robot mechanics and control architectures, and development of intelligent robotic applications, including but not limited to:

- Novel design and applications of robotic systems; micro and nano-scale robots
- Dexterous grasping, handling and intelligent multi-finger hand control
- Intelligent cooperating and service robots; bio-inspired and swarm robotic systems
- Human-robot interfaces; natural-like interaction of humans with robots
- Advanced robot control; robot vision systems and visual servoing techniques; intelligent information technologies for cognitive robots
- Mobile, humanoid and walking robots
- Robot integration in holonic manufacturing; underwater and spatial robots
- Medical robots and bionic prostheses; personal robots for ambient assisted living
- Education in robotics; history of automation and robotics

Human activities in many sectors are nowadays supported or replaced by robots, which range from standard robots for industrial or service applications to autonomous robots for complex activities, such as underwater and space exploration. The great versatility and flexibility of nowadays robots allows them to be employed in different sectors, to perform very diverse tasks.

A number of papers report advances in robot control and integration in production and service tasks. In order to adapt themselves to the environment and characteristics of material flows, robot systems are often equipped with vision systems. Vision-guided robot motion using visual servoing methods provide best performances in the generation of accurate, task-oriented motion patterns. Integrating Visual Quality Control (VQC) services in the manufacturing environment is described as product traceability means. In the context of agent-based manufacturing reconfiguring, this section of the conference also approaches planning and tracking of cooperative activities in robot teams.

The problem of dual or multiple-arm robot cooperation for handling objects in service tasks is approached from the point of view of path planning, kinematics, and movement synchronization. Two solutions can be recognized: hybrid position-force control in dual-arm tasks and I/O communication with master-slave synchronization.

There are also analyzed new methods of using robots to interact with humans (natural interaction) to provide assistance services. Using depth sensors, the robots are able to detect the human operator and to avoid collisions. Collision avoidance is done using depth sensors which monitor the activity outside and inside the multi-robot system workspace using skeleton tracking (e.g., with the Kinect sensor), which allows the robot to detect collisions and stop the motion at the right time

Papers in the conference address the development of software interface for natural-like interaction of humans with personal robots. This type of interaction is considered for communication (models of hand gestures are established that allow many natural gestures to be interpreted by the personal robot) and emulation of human skills, routine tasks (extracting reusable task knowledge from visual observation of human gestures, learning operational activities from human demonstration). These papers describe: spatial and temporal modelling of communicative and manipulative gestures; hand gestures analysis and recognition based on multiple-image processing; reusable task knowledge extraction from visual observation of human performance and action reproducer (human tasks emulator); visual servoing for motion tuning.

The conference topics address theoretical principles and methods, implementing solutions and tools for visual servo control of robot manipulators in grasping tasks. Guidance vision is presented as an advanced motion control method, which provides flexibility to robots integrated in manufacturing cells with unstructured environment and in line quality inspection, e.g. in the glass industry.

The received papers have been grouped in nine technical sessions:

- Robot integration in industrial applications
- Grasping analysis, dexterous grippers and component design
- Advanced robot motion control
- Robot vision and sensory control
- Human-robot interaction and collaboration
- Modelling and design of novel mechanisms and robotic structures
- Robots in medicine and rehabilitation
- Tracking systems and Unmanned Aerial Vehicles
- Autonomous task learning, motion planning and scheduling

All these aspects are treated in the present RAAD'15 preprints volume, which we hope you will find useful reading.

April 2015, Bucharest

Theodor Borangiu

ISC Coordinator for RAAD 2015

Contents

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RAAD 2015 Conference Program

Wednesday May 27, 2015

08:15 – 09:00	Registration
09:00 – 10:00	**Plenary Session 1**: Toward Lifelong Learning, Adaptation, and Adjustability for Personalized Human-Robot Interaction, *Professor Adriana Ţăpuş, ENSTA-ParisTech, France*
10:00 – 10:30	Coffee break
10:30 – 12:30	**Technical Session A**: Robot integration in industrial applications
12:30 – 14:00	Lunch
14:00 – 16:00	**Technical Session B**: Grasping analysis, dexterous grippers and component design
16:00 – 16:30	Coffee break
16:30 – 18:30	**Technical Session C**: Advanced robot motion control
20:00 –	Welcome cocktail, Grand Hotel Continental

Thursday May 28, 2015

08:00 – 08:30	Registration
08:30 – 09:30	**Plenary Session 2:** Carl CLOOS - A Provider of Advanced Robotic Solutions for Arc Welding, *Dr. Nicolae Joni, General Manager of Robcon TM, Romania*
09:30 – 10:50	**Technical Session D:** Robot vision and sensory control
10:50 – 11:20	Coffee break
11:20 – 12:40	**Technical Session E:** Human-robot interaction and collaboration
12:40 – 14:00	Lunch
14:00 – 16:00	**Technical Session F:** Modelling and design of novel mechanisms and robotic structures
16:00 – 16:30	Coffee break
16:30 – 17:50	**Technical Session G:** Robots in medicine and rehabilitation
19:45 –	Gala dinner, Restaurant Crama Domneasca, historical centre of Bucharest

Friday May 29, 2015

08:30 – 10:30	**Technical Session H:** Tracking systems and Unmanned Aerial Vehicles
10:30 – 11:00	Coffee break
11:00 – 13:00	**Technical Session I:** Autonomous task learning, motion planning and scheduling
13:00 – 13:05	Wrap up
13:05 – 14:30	Lunch

Technical Session A:

Robot integration in industrial applications

On Applying CSP for Coordination of a Multi-Robot Holonic Manufacturing Execution System

Doru Pănescu and Gabriela Varvara

"Gheorghe Asachi" Technical University of Iasi, Dept. of Automatic Control and Applied Informatics, Romania
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The use of distributed constraint satisfaction problem for the coordination of holonic schemes including multi-robot systems is investigated. The formalism needed to apply the constraint satisfaction approach for manufacturing problems is discussed and exemplified with a case study. The example refers to a scenario in which two order/product holons are simultaneously operating. According to the imposed manufacturing goals, they have chosen partially ordered plans (displayed in Fig. 1a), meaning that the sequences of actions within plans are not entirely settled. This form of plans creates flexibility and is appropriate for the holonic distributed mechanism.

The resource holons (part of them are shown in Fig. 1b) that should be involved as actors in the established plans must be allocated. The paper shows how the proposed distributed constraint satisfaction method can solve such a problem. The obtained advantages are: safe operations even in cases with conflicting goals without using any centralized component, and an efficient use of knowledge possessed by different types of holons. An implementing possibility is introduced, too.

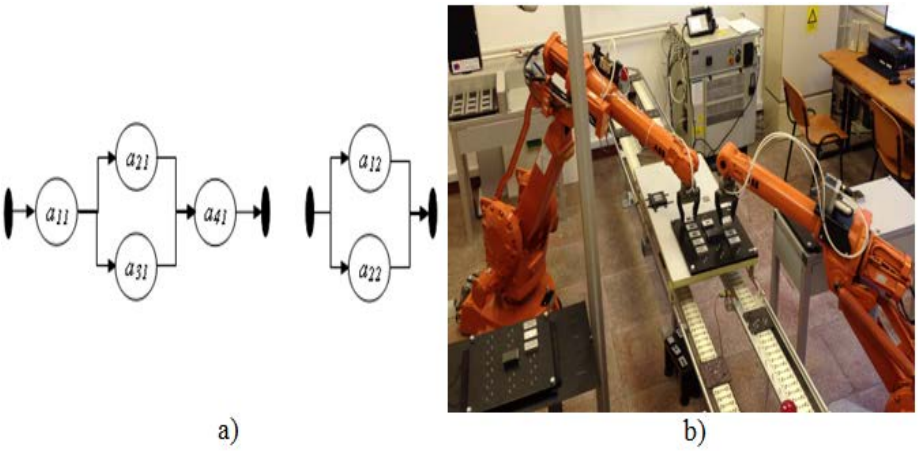

Fig. 1. a) Plans of two order/product holons b) The experimental manufacturing environment

Establishing Optimal Energy Working Parameters for a Robotized Manufacturing Cell

Silviu Răileanu, Theodor Borangiu and Florin Anton

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The paper proposes a method for measuring energy consumption of single phase equipment. Although it can be used in different domains, the solution targets the shop floor level of robotized manufacturing systems. The paper focuses thus on the energy consumption of industrial robots for different operation types. This solution will be extended in the second part of the paper for a set of workstations working together in order to minimize energy consumption at global level for a batch of products.

The paper is organized as follows: motivation of energy measurement for industrial equipment; structure of the energy measurement and operation execution system; scenarios used to analyse energy consumption for a single industrial robot, data acquisition and selection of the optimal operating parameters based on this data; extension of the energy optimization solution to a set of industrial robots working together in a job-shop manufacturing layout; final conclusions and perspectives of future research.

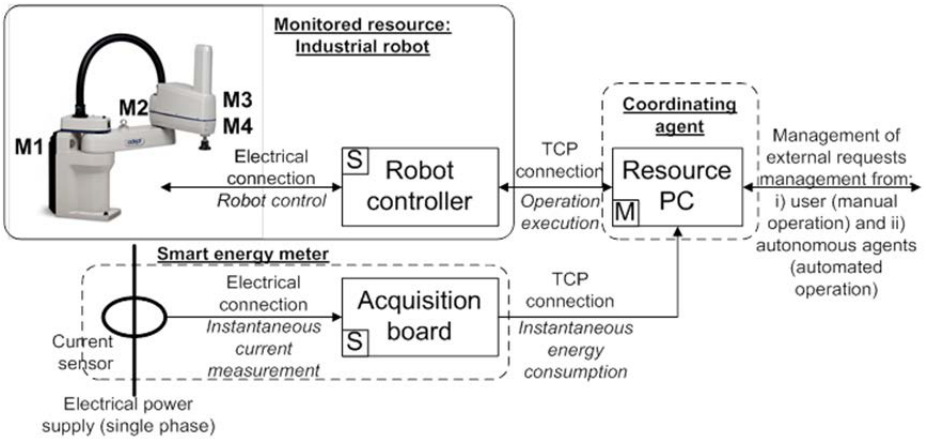

Fig. 1. Energy measurement system

ROS Based Safety Concept for Collaborative Robots in Industrial Applications

Stephan Kallweit[1], Robert Walenta[1] and Michael Gottschalk[2]

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The production and assembly of customized products increase the demand for flexible automation systems. One approach is to remove the safety fences that separate human and industrial robot to combine their skills. This collaboration presents a certain risk for the human co-worker, leading to numerous safety concepts to protect him. The human needs to be monitored and tracked by the safety system using different sensors (Fig. 1). The proposed system consists of a RGBD camera for surveillance of the common working area, an array of optical distance sensors to compensate shadowing effects of the RGBD camera and a laser range finder to detect the co-worker when approaching the work cell. The software for collision detection, path planning, controlling the robot and predicting the behaviour of the co-worker is based on the Robot Operating System (ROS). A first prototype of the work cell shows that with advanced algorithms from the field of mobile robotics a very flexible safety concept can be realized: the robot not simply stops his movement when detecting a collision but plans and executes an alternative path around the obstacle.

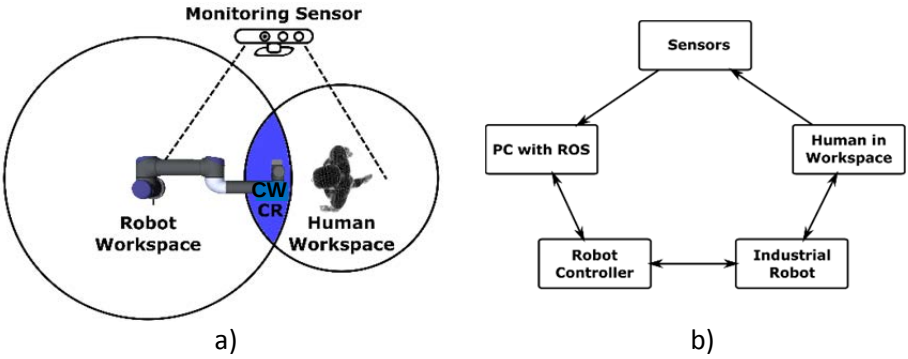

Fig. 1. (a) Collaborative Workspace (CW) between human and robot monitored by multiple sensors. (b) Interaction diagram showing aspects of the concept used for safe human robot collaboration.

Experimental Platform for Performance Tests of Compliant Robotic Devices

Jaroslav Hricko

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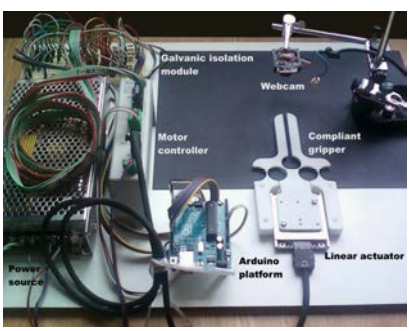
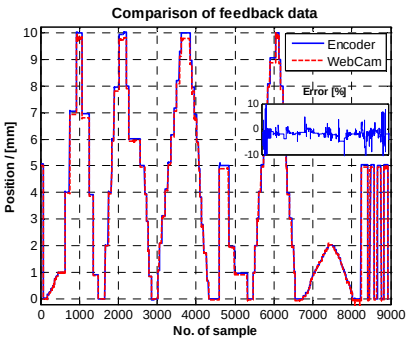
The design process of mechatronic devices is usually based on Model-Based Design (MBD) methods. This approach allows obtaining properties and functional behaviours of designed devices what at lower prototyping costs. Building prototypes is usually the last operation before real manufacture of products and includes several experimental tests for verification of future parameters. As building prototypes is the most expensive part of the design process, the HIL (Hardware-in-the-loop) and SIL (Software-in-the-loop) simulation methods are strongly recommended to decrease final production cost.

This paper deals with the design of a specific test bed for evaluating performance quality for compliant robotic devices (see Fig. 1 a). The proposed equipment permits verifying parameters and differences between mathematical models of flexible parts and real characteristics that usually differ from models. Then, the structures and parameters of necessary compliant devices can be optimally designed.

In order to perform the first experiments (Fig. 1a), mutual interconnection between actuators and control system working in the MATLAB environment was considered. Two approaches of position feedback are implemented; Fig. 1b compares the two sets of feedback data.

An example of possible application in the development of a micro-gripper is described. The platform enables performing tests and verification of control algorithms (control of actuator, sensing positions and image processing).





a) b)

Fig. 1. a) Experimental platform for tests of compliant robotic devices b) Comparison of data from position feedback sensors

Cooperative Assembly Using Two Industrial Robots

Mădălin P. Sbanca and Gheorghe L. Mogan

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Compared with humans, the robots have lack the capability of taking decisions in critical situations**.** The paper presents aspects concerning a master-slave robot cooperation method allowing to accomplish assembly task using two industrial robots with own controllers. The scope of the study is to realize a robot collaboration system. To achieve this goal, the assembly process using one single robot was extended to multi robot operation. The first step of the research consisted in developing a control algorithm using a master controller outside over the two robots controllers. In the second step the feedback signal from a force sensor was used.

The inputs of this system are the parameter prescribed by the user. The feedback is composed by the actual positions of the robots and the force cell values for three orthonormal directions. The output of the system is the set of new positions of both robots, generated by the application according to the implemented dual control law.

The reported case study confirms good coordination results of the dual robotic platform of industrial type. Two parallel communication systems were developed for the two robots: one for transmitting the current robot positions and the new computed ones that provide robot synchronization, and a second one used to synchronize the position updates with the force feedback. The implemented interface allows the user to make the process parameterization; he can also choose the positioning method and the feedback signal. The user can configure the operating mode: manual positioning or manual update of actual robot positions, synchronization of the signals or manual manipulating of the robot using a peripheral controller. The research led to improvements of the automatic control modes of the cooperating robots. Nonlinear bi-positional and tri-positional control laws were implemented in the hierarchical controller. Figure 1 presents the directions of the force and position trajectories which show a certain similitude, which confirms a strong dependency relation between these two parameters - position and force – tracked by the external master controller.

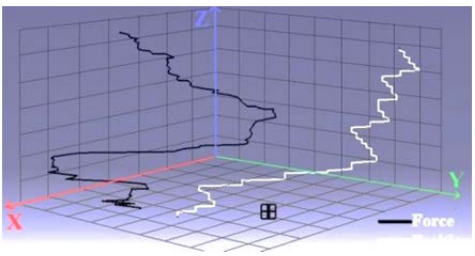

Fig. 1. Positions dependency on force feedback

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The Beginning of the Automation. A Brief Review on the Automatic Devices in the Hellenistic Age

Cesare Rossi

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Some examples of the most interesting automatic devices of the Hellenistic Age are presented. These devices can be considered the first examples of automatic mechanical systems, thus representing the precursors of modern automation; they clearly show how the concept of automation was present in the minds of ancient scientists and engineers since the II century B.C. or even earlier. The devices also clearly show the surprising modernity of the knowledge of the ancient scientists and engineers, conceiving both the mechanical designs and their construction. Moreover, the presented devices span a rather wide range of applications fields. The automatic systems that were chosen are presented in the paper by grouping them by inventor. The latter are: Archimedes, Heron of Alexandria, Ctesibius, Dionysius of Alexandria and Philon of Byzantium.

The presented examples show how advanced were our predecessors about 2000 years ago. Most of their inventions, in fact, were beaten not earlier than in the XVIII Century. So, we should give them a tribute for having "placed the foundation" of our knowledge and our comfortable life nowadays.

Moreover, it can be interesting (and may be also instructive) to observe how some devices represent solutions of problems that were obtained with a design that shows a brilliant simplicity.

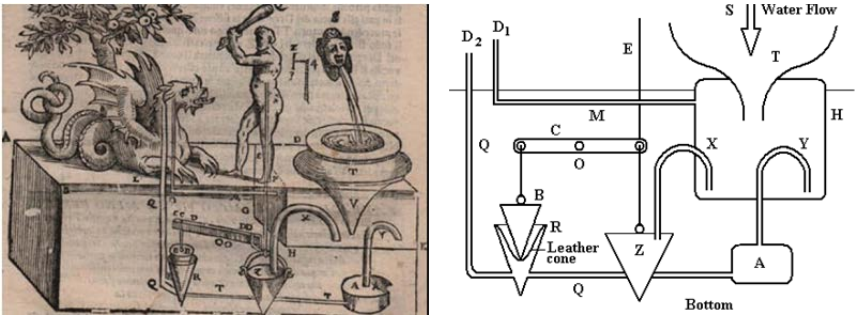

Fig. 1. Reconstruction and working principle of Heron's automaton representing Heracles and the Hydra

Technical Session B:

Grasping analysis, dexterous grippers and component design

Gripping Analysis of an Underactuated Finger

Francesco Penta, Cesare Rossi and Sergio Savino

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In the paper a theoretical study about the gripping of an underactuated tendon driver finger is presented. The studies presented in the paper have been performed to analyse the capability of the proposed device to apply forces on the grasped object, and to analyse the behaviour of the contact actions during the grasping. The analysis of two models is reported and the results of some simulations are shown.

Models were also presented to carry on the grasping analysis of an underactuated finger. The presented analysis shows the suitability of such a finger to be used in hand prosthesis or in a robot grasping end-effector. This is basically possible because of the following aspects:

1. The finger shows a good self-adaptability to the object shape.
2. The tendon system permits suitable grasping forces in the contact between the phalanxes' inner surface and the object surface.
3. The forces above are obtained with relatively small traction forces of the tendon.

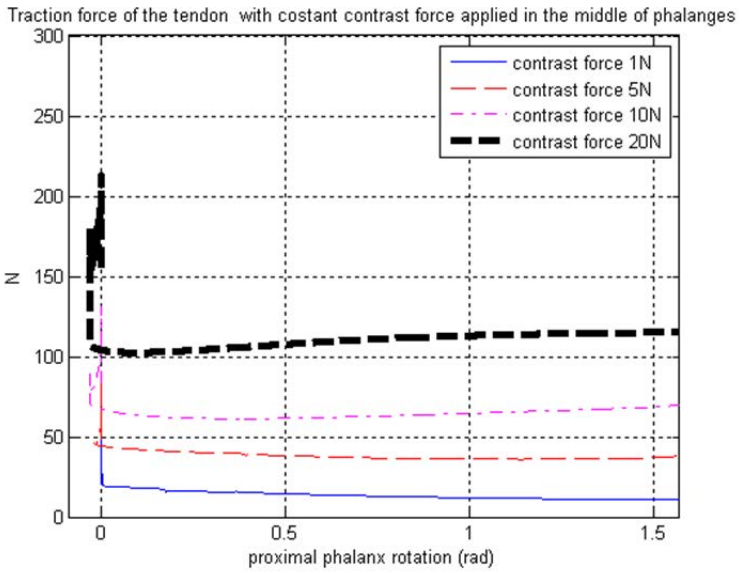

Fig. 1. Traction force with constant contrast force in the middle of phalanges

Dynamic Behaviour of an Underactuated Finger

Vincenzo Niola[1], Cesare Rossi[1], Sergio Savino[1] and Pavel Potapov[2]

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[2]Moscow Automobile & Road Construction Institute, Moscow, Russia
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The paper presents a theoretical study about the dynamic behaviour of an under-actuated finger. By modelling the equation of dynamics, two kinds of fingers were studied: the first with equal phalanges and the second with three different phalanges, whose parameters are similar to those of a human finger. The results obtained allow choosing the sequence of closing the finger, by modifying some geometrical parameters of the phalanges.

A computing example is also presented. It analyses both the force necessary for closing the finger and the finger closing sequence. Both aspects are very important to optimize the finger design; the analysis concerns in general the parameters of the whole mechanical system and in particular the tendon positions. These aspects, naturally, cannot be obtained only by kinematic investigation.

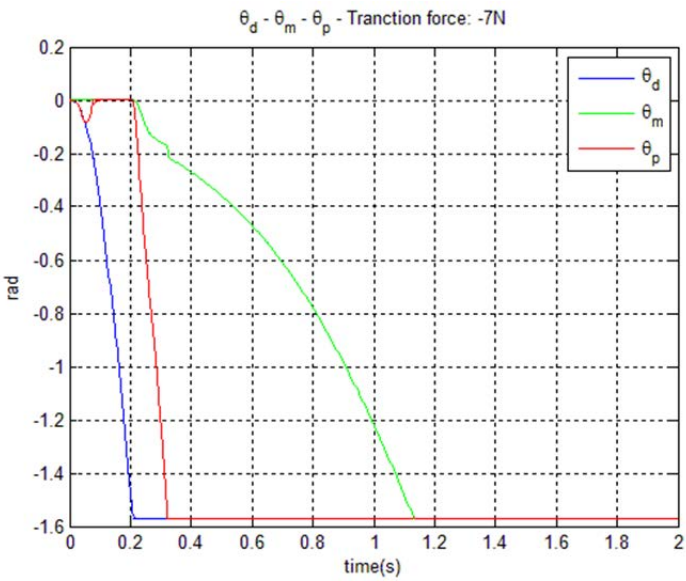

Fig. 1. Phalanges' behaviour with traction force of 7 N

Swivel Walker with Electro Motoric Module and Designation of Stability

Mikuláš Hajduk and Jozef Varga

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The paper describes the design of a swivel walker with electro motoric module supporting the movement of handicapped people. First the functional principle and the design methodology of the equipment are presented. The initial structure of such equipment was up to now exclusively mechanical; therefore, moving assisted with such a mechanical swivel walker is physically demanding and for this reason a swivel walker with electro motoric modules is proposed. In the final part of the paper, the stability principle of two legged equipment is analysed and the height limit CoG position to ensure swivel walker stability is determined.

The proposed swivel walker with electro motoric consists of a base platform, rocking plates, bushing (combined axial and radial bearings) and return springs.

The electro motoric module consists of a 24 V DC motor, worm gear box, motor frame, tilting structure, draw spring, swivel eye joint and stopper. The spring is drawing the stopper to the initial position. At every tilting of the structure, the stopper is returned back to the initial position and thus prepared for next contact with the base at a defined angle, so that the entire surface of the stopper is in contact with the base. The electro-motoric module consists of right and left worm gear box.

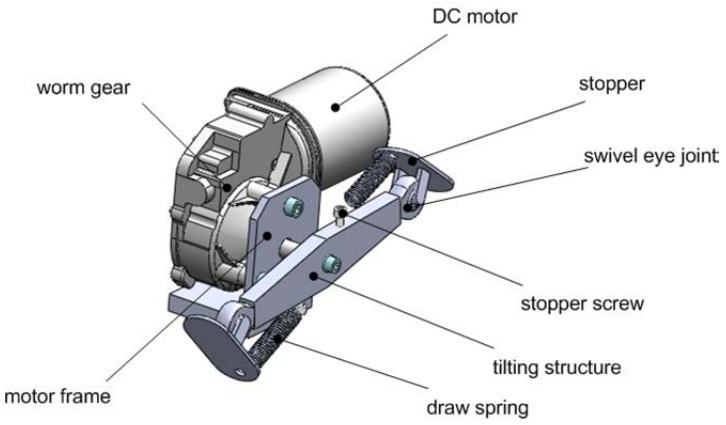

Fig. 1. Structure of the electro motoric module

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Resistance Feedback of a Shape Memory Alloy Wire

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The identification of a model able to relate the deformation of a Shape Memory Alloy (SMA) wire to a state variable easily measured is widely studied in recent years. The electric resistance (ER) of a SMA wire varies depending on its martensite and austenite fraction, so the determination of the biunivocal relationship between the wire shortening and its electric resistance allows to "preview" the position of the SMA wire. In this way the resistance of the SMA wire can be used as the feedback variable in a control system. A test bench was first used to determine the above mentioned relationship, and after this the relation was used in a fuzzy control system to impose a desired position to a SMA wire and to check the response of the device. This control does not need a position sensor and this is a certain advantage in terms of cost, overall dimensions and weight of possible applications. The performances of this position control with resistance feed-back are good and adequate for lots of applications; in particular it is suitable for all applications in which there is no space to place a position sensor like in aerospace applications or micro manufacturing.

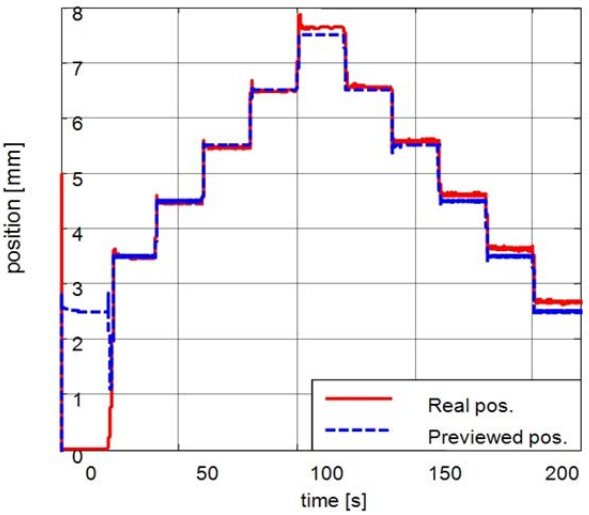

Fig. 1. Example of test with step wave; constant load of 10 N, Nitinol HT wire, diameter 250 μm, length 200 mm

Study of 3-Jaw Gripper Architectures

Giuseppe Quagliaand Luca Girolamo Butera

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The growing use of robots in automated industrial processes involves the development of solutions adopted for grasping objects. These devices or grippers are used for handling components and products that can be made from different materials and have different shapes and dimensions. Current demand for more cost-effective and flexible industrial processes requires smart grippers able to perform a variety of functions. In this paper we present a comparison of different architecture solutions for an industrial gripper with specific features. Using a 3-Jaw gripper model, we consider two different ways to grasp the object. In particular we introduce all requirements of the gripper, the process design for reaching the target of the project using a modular approach and the possible architectures of gripper.

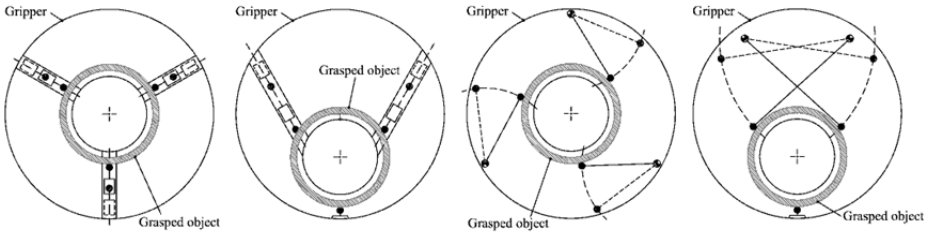

Fig. 1. Kinematic architectures for radial impactive grippers

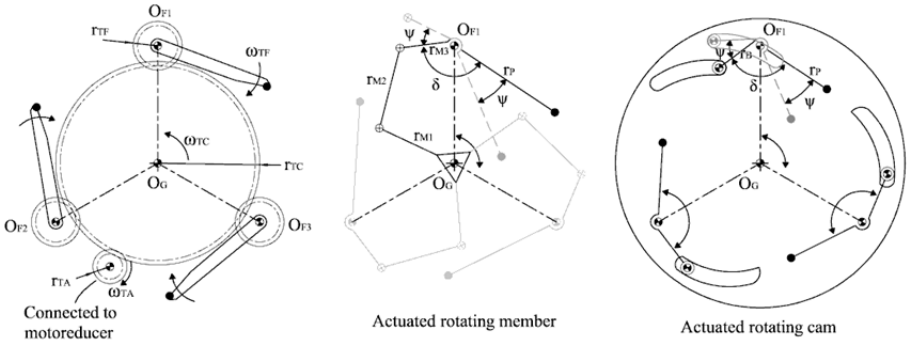

Fig. 2. Transmission and synchronization group solutions

Flexible Actuator for Biomorphic Applications: Performances and Energy Consumption Evaluation

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The paper describes an experimental performance evaluation of a flexible actuator, specially conceived for propulsion of biomorphic robots. Static and dynamic characteristics are presented, particularly referring to the energy consumption. The goal of this work is to evaluate the operating characteristics and the energy cost for a particular bending actuator used for aquatic fish-like robot propulsion.

The conception is based on test rigs especially designed. The article reports a first experimental investigation on a special flexible actuator (Fig. 1), fluid operated, particularly conceived for biomimetic propulsion of fish-like robots. Some results are referred and discussed to evaluate the advisability of this type of actuator to move the fish-like fin of an aquatic robot.

This study permitted to individuate the main problems that have to be faced and solved in future work, namely optimization of the fluid power transmission and the choice of materials with low internal friction for the actuator's body.

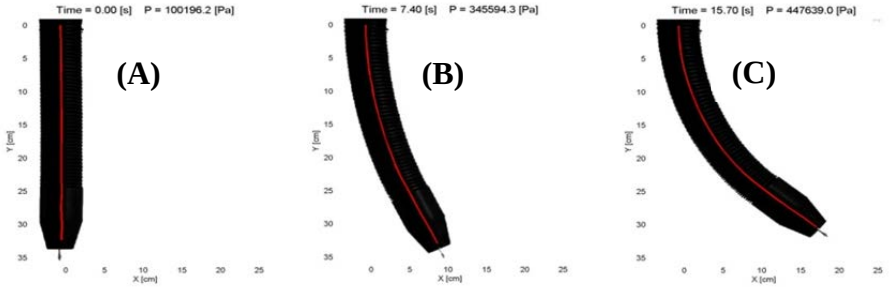

Fig. 1. Sequence of deformed geometry increasing the air supply pressure from 0 to 4.5 bar relative in only one chamber

Technical Session C:

Advanced robot motion control

Optimizing Trajectory Points for High Speed Robot Assembly Operations

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The work presented in this paper has been done in order to optimize the relation speed – trajectory length for an assembly task. The assembly task consists in fixing an engine part with 8 screws, the screws are already inserted and pre-fixed but not tightened, in some cases the screw must be screwed for a length of 1 cm, and then tightened at 25Nm. The operation duration (cycle time) should be of maximum 45 seconds measured from the time the pallet enters in the working area until the pallet exits the working area. Due to the conveyor operation which takes 12 seconds to place the pallet in the working position and to remove the pallet from the working area, only 33 seconds remain for the robot operation, including the operation time of the screwdriver placed on the robot.

The paper presents a solution which minimizes the distance which the robot end effector should travel, and maximizes the robot speed to obtain a robot cycle time under 33 seconds, also avoiding collisions. A schematic representation of the validation algorithm is presented in Fig. 1.

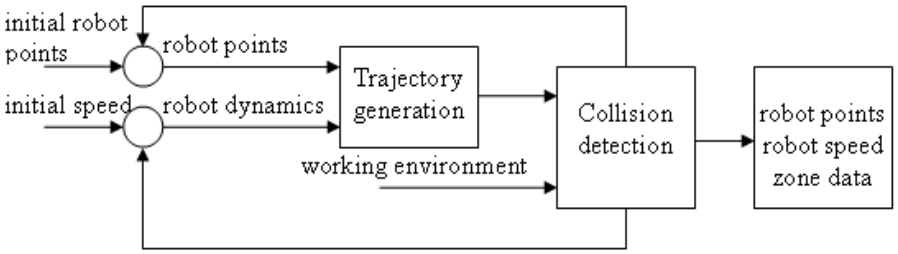

Fig. 1. The schematic of the position/speed validation algorithm

Cost Function-free Optimization in Inverse Kinematics of Open Kinematic Chains

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In this paper a simple, geometric interpretation-based application of the Gram-Schmidt algorithm is suggested to solve the differential inverse kinematic task of open kinematic chain robot arms of non-special construction, when no closed analytical solution exists.

The traditional ways of solving various tasks ”optimally” in control technology and robotics are normally based on the minimization of some cost function (or functional). On the basis of function minimization, various ”generalized inverse matrices” can be introduced that have especial significance in the case of redundant manipulators where the possible solutions are ambiguous, therefore various choices being available.

The main advantage of our approach is that, while a generalized inverse solves the problem for all the possible motions, in this case we provide the solution only for the actually desired motion of the robot arm. Via completion with an error feedback term with respect to the workshop frame, this method was applied in a Kinect-based system to realize hand-controlled rotation-free translation of a virtual work piece by help of a simulated robot. The method is presented via simulations using a redundant arm structure.

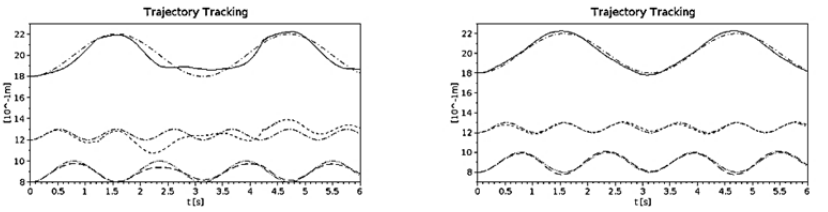

Fig. 1. Trajectory tracking in $\mathbb{R}^3$: non-optimal order (LHS), optimal order (RHS) [x_1, x_2, x_3 nominal trajectories dash-dot, long dash-dot, dash-dot-dot]

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Control and Coordination System Supported by Biologically Inspired Method for 3D space "Proof of concept"

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The biologically inspired method described in the paper has been developed to solve exploration or monitoring tasks. The presented model is a decentralized adaptive system with a shared memory representing the environment. Our approach is based on cellular automata. Each robot in the system has its own representation of an environment (a map). The map of the environment of a robot is a 3D cellular grid. The robot uses the grid for navigation and as a memory. Each situation which can be observed by the robot is entered into the map. Robots cannot communicate directly in our approach. Each robot communicates with the other robots trough pheromone marks in the environment. When a particular robot moves to a new location, the robot marks this location by its pheromone mark, principle which is shown in Fig. 1. Since it is difficult to create a pheromone mark in the real world (humidity, wind, evaporation, etc.), virtual pheromone marks were used.

This paper reports detailed investigation of the properties of the proposed biologically-inspired algorithm. The complete functionality of the solution is demonstrated.

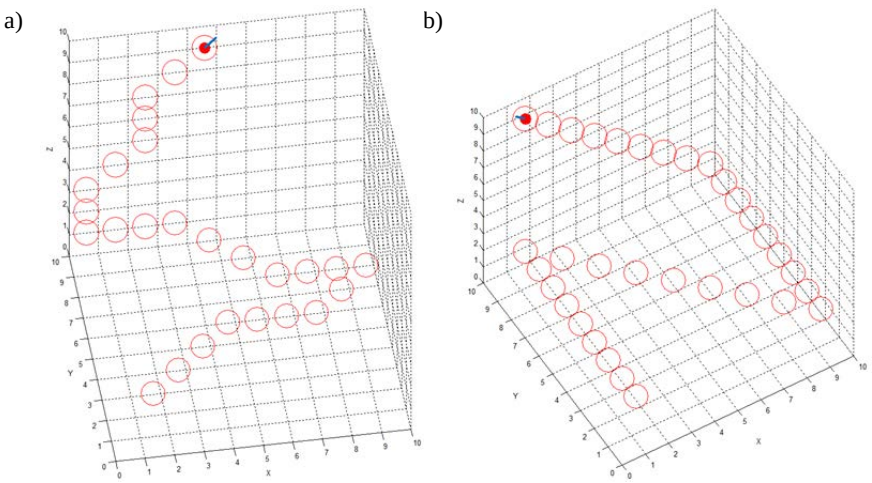

Fig. 1. Motion of the robot in 3D cellular space

Preliminary Ideas on the Odometry of an Omni-directional Mobile Robot

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Omnidirectional mobile robots are very attractive because they guarantee a very good mobility, which make them appropriate for moving in tight areas while avoiding obstacles or finding their way to the next location. To perform such tasks accurately a precise estimation of the position is essential.

The design of an omnidirectional robot equipped with original modified Mecanum wheels (Fig. 1), as well as its control are presented in this paper. Also, preliminary ideas about the design of a simple and novel odometer are discussed. This odometer (Fig. 2) was not yet implemented and tested experimentally up to now in order to prove its effectiveness. This work will be the subject of future research.

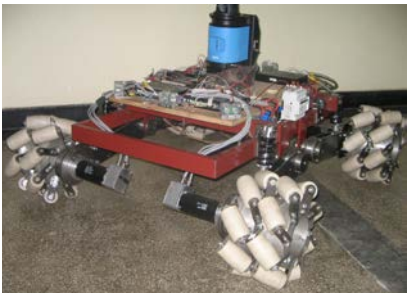
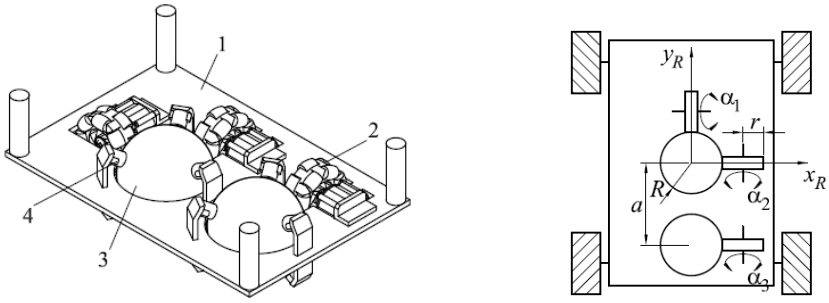


Fig. 1. Robot prototype



(a) (b)

Fig. 2. Odometer principle: a) 3D view; b) top view of the robot with odometer

Study of Controlled Motion of Exoskeleton Moving From Sitting to Standing Position

Sergey Jatsun, Sergei Savin, Andrey Yatsun and Andrei Malchikov

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The object of this study is the exoskeleton that has two legs, each of them consisting of three rigid bodies connected through rotational joints. The object of the study is to present a strategy for performing motion that takes an exoskeleton from sitting to standing position. To achieve this goal analytical expression describing the change of generalized coordinates with respect to time were derived. The motion of the mechanism as described by those expressions, meets a number of criteria that are presented in the paper.

Using obtained expressions, a control system was designed. The paper includes criteria that can be used to assess quality of work of the control system. Using those criteria the controller was finally tuned.

A way to improve the quality of work of the control system is also described in the paper. It requires introducing a new element in the control system design, which changes the structure of the control system. The linear correction element that was introduced in the control system caused a significant improvement of the quality of the work of the control system, but there still remain oscillations to be eliminated in future research.

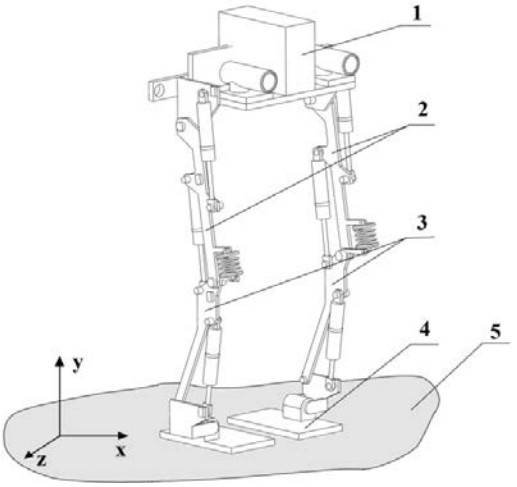

Fig. 1. 3D model of lower limbs of the walking robot (1– torso, 2 – hip, 3 – shin, 4 – foot, 5 – bearing surface)

Robotic System Equipped by Catapult

Sergey Jatsun, Oksana Loktionova, Lyudmila Vorochaeva and Alexander Vorochaev

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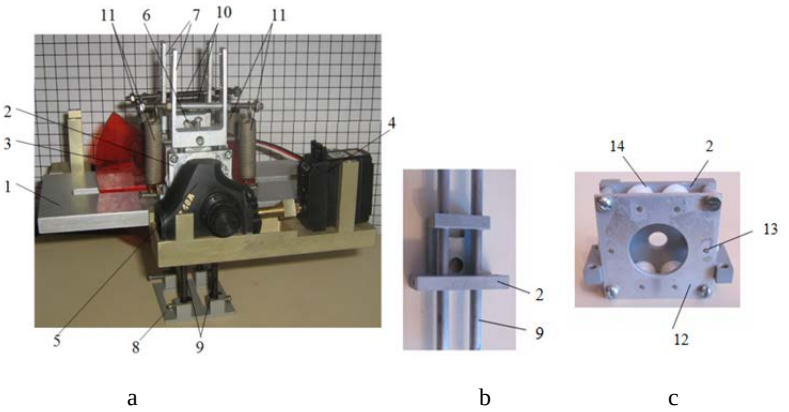
The paper presents an experimental stand including the layout of a robotic system moving in jumps from the surface, equipped with onboard catapult, and the related measurement tools (Fig. 1).



a b c

Fig. 1. Photo: a: experimental stand of robotic system, b: sliding slideways, c: rolling slideways: 1: base, 2: stand, 3: cam, 4: servo-motor, 5: gear, 6: pusher, 7: fastener, 8: foot, 9: rod, 10: fastening element, 11: spring, 12: lid, 13: axis, 14: roller

The sequence of stages of the jump and the mathematical model of the robot movement, as well as the distinctive features characterizing the change of generalized coordinates and the initial conditions of motion at each stage are presented in the paper.

Special attention is paid to investigating the influence of acceleration on the height of the jump; a model of the friction force is proposed which includes two components; one which uses materials in the translational pair, and the second one due to the flexural deformation of the rods.

The comparative analysis of results of numerical simulation and the experimental studies confirm the adequacy of the mathematical model. It allows establishing that the device moving in jumps from a surface, and being equipped with progressive accelerating pairs, when using the sliding slideways is impractical in view of the significant reduction efficiency with increasing accelerating force which is caused by deformation and jamming. Therefore it is preferably to use rolling slideways which allow compensating deformation in the rods and keeping motion efficiency constant and independent on the force generated during acceleration.

Technical Session D:

Robot vision and sensory control

A Control Predictive Framework for Image-Based Visual Servoing Applications

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In this paper, a review of predictive control algorithms developed by the authors for visual servoing of robot manipulators with eye-in-hand configuration is presented. Using these algorithms, a control predictive framework was created for image-based visual servoing (IBVS) applications, whose basic idea is presented in Fig. 1

Firstly, considering the point features **f**(*k*), we introduced in 2008 an internal model predictor based on the interaction matrix which predicts the behaviour of the plant $\mathbf{f}(k+i\,|\,k)$, $i=\overline{1,h_p}$ over the prediction horizon. Due to the dependency of the interaction matrix of depth, we put Z as vertical axis. Secondly, distinct from the set-point trajectory $\mathbf{r}(k+i\,|\,k)=\mathbf{f}^*$, we introduced in 2011 the reference trajectory $\mathbf{w}(k+i\,|\,k)$ using the concept from predictive control. Finally, minimizing a sum of squares of predicted errors, the optimal input trajectory $\mathbf{v}_c(k+i-1\,|\,k)$ is obtained and only the first element $\mathbf{v}_c(k\,|\,k)$ is applied to the plant, where $\mathbf{v}_c=[\mathbf{v}^T\ \boldsymbol{\omega}^T]^T$ is the camera velocity screw with its translational $(\mathbf{v})$ and rotational $(\boldsymbol{\omega})$ components.

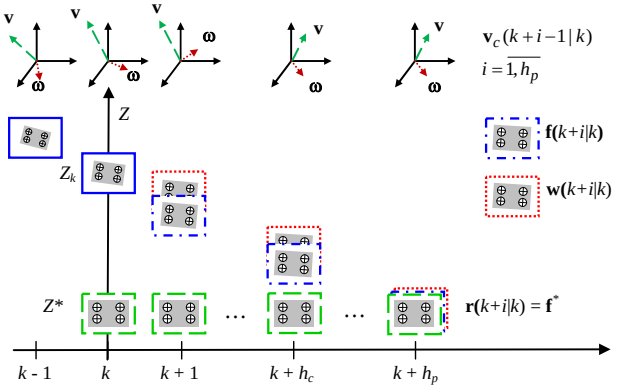

Fig. 1. Predictive control: the basic idea for IBVS applications

Based on the new concept of predictive control for IBVS systems, we developed a cascade structure for motion control of robot arms. The inner loop regulates the camera velocity screw $\mathbf{v}_c$ and the outer one the robot arm motion in order to obtain a desired position described by $\mathbf{f}^*$. In this paper, a simulator for the predictive cascade structure developed in Matlab is also presented together with the simulation results.

Motion Leap Compared to Data Gloves in Human Hand Tracking

Cătălin Moldovan and Ionel Stareţu

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The paper presents a comparative analysis of the ways in which human hand gestures are currently captured and then used in virtual reality environments as a mean of direct, non-intrusive interaction between human and computer. As an alternative to the Microsoft Kinect Sensor, in 2012 a new sensor, Motion Leap, was developed. The paper analyzes how a non-invasive technique based on Motion Leap might be used to capture various gestures from a human hand, compares it with data glove utilization and uses it to control a virtual hand. This research is part of a program aiming at using non-invasive techniques to control a robotic hand and arm. Compared to other methods which use different types of data gloves, the Motion Leap device enables new ways of non-intrusive interactions. Using the Motion Leap device, the authors have developed a system capturing and recognizing human hand and gestures, the results of the analysis being then sent to virtual reality environment for complete processing. The sequence of gestures is captured using different light conditions (natural or artificial light) and different visualization points. Fig. 1 shows gestures used in the recognition process. It was observed that gesture capture dos not depends on the light condition, if Motion Leap is used. Fig. 2 shows recognized hand gestures, the hand joints being displayed using the Motion Leap internal visualizer. Once a gesture is detected, the functional simulation component Hand COMMANDER is notified to transmit the data to the virtual environment for execution. The sequence obtained from the gestures captured above is shown in Fig. 3.

Fig. 1. Human gestures for which the recognition will be run

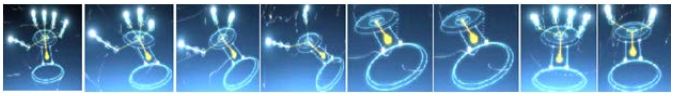

Fig.2. Gestures recognized using the Motion Leap device

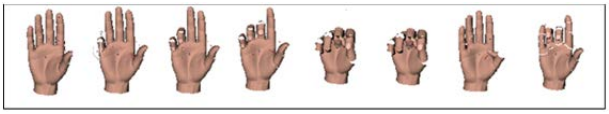

Fig. 3. Gestures transmitted to the virtual environment

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Considerations for Robot Vision in Glass Production

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The paper presents considerations for implementing and using robot vision in glass container production. The analysis concentrates mainly on the forming processes of shell glass objects that are still produced with considerable amount of manual labour.

Most operations in a predominantly manual glass object forming environment are driven by the experience of skilled operators and must result in a determined intermediate surface shape and thickness distribution. To automate these operations, the use of robots would be the right solution, provided that their tasks are conditioned by real time computer vision systems able to provide permanent information about the formed object's shape (that is, about the surface geometry).

As part of automation projects carried out for a glass production company, we investigated real-world conditions that such a vision system should cope with. One research contribution was to systematically identify a number of important particular requirements and conditions, originating from high and ever-changing temperatures (see Fig. 1) and from specific production environment conditions (see Fig. 2).

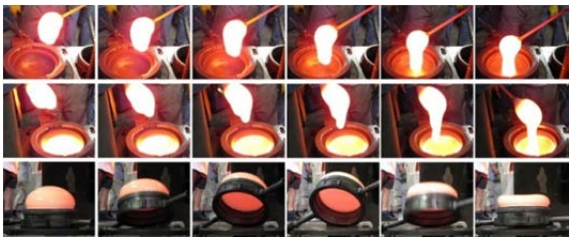

Fig. 1. Shape change speed of a high-temperature glass object: a) 1st row – solid gob, form changes due to gravity in 500 milliseconds; b) 2nd row – solid gob, lower-viscosity glass, form change in 500 milliseconds; c) 3rd row: glass shell, change due to gravity in 800 milliseconds.

Fig. 2. Influence of spontaneous ignition on images acquired for characterization of the glass object surface. The image quality is degraded by both fire and smoke. The images in the two rows show the difference when using automatic and fixed aperture control.

Rotation Angle Determination for Rectangular Objects Using an Infrared Sensorial System

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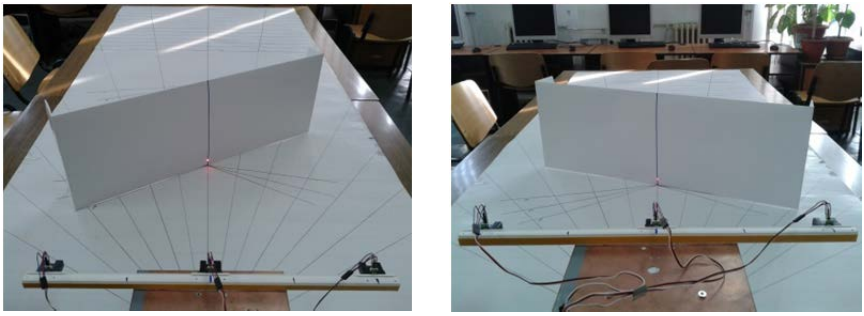
Mobile robots are extensively investigated in various research laboratories, due to their applications diversity. Currently, the interest is focused toward applications of mobile robots within unstructured working environments. The successful running of these types of applications is subject to the possibility of localizing obstacles within the working environment. This paper deals with a method to determine the position and the orientation of a rectangular object with respect to several infrared sensorial elements. Locating an object requires the determination of the reference coordinates of this object and of the object orientation relative to an axes system. Research in this domain aims identifying new sensorial variants in IR which might be successfully integrated within the construction of mobile robots. The method presented in this paper to determine the rotation angles of objects can be successfully implemented in the control system of mobile robots. Figure 1(a, b) shows images of the object positioned on the experimental stand.



a) b)

Fig. 1(a, b). Images of an object placed in the working scene

Technical Session E:

Human-robot interaction and collaboration

Individuals with Autism: Analysis of the First Interaction with Nao Robot based on their Proprioceptive and Kinematic Profiles

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Our research aims to develop a new personalized social interaction model between a humanoid robot and an individual suffering of Autistic Spectrum Disorder (ASD), so as to enhance her/his social and communication skills. In order to define individual's profile, we posit that the individual's reliance to proprioceptive and kinematic visual cues will affect the way an individual suffering of ASD interacts with a social agent.

We describe a first experiment that defines each participants' perceptive cognitive and sensorimotor profile with respect to the integration of visual inputs. We succeeded to form 3 groups with significant different behavioural responses inside our subject pool formed by 7 adults and 6 children with ASD. In a second experiment, we presented the Nao robot to all of our participants. We video-analyzed their behaviours and compared them to the profiles we defined.

In view of the obtained results, this first interaction confirmed our hypothesis: participants with a weak proprioceptive integration and strong visual dependency had more successful interaction than participants with an overreliance on proprioceptive input and hypo reactivity to visual cues.

(a) (b)

Fig.1.Experiment Setup: (a) Capture of the virtual room used in the experiment; (b) Experimental setup for the adults group in condition C3

Human Robot Collaboration for Folding Fabrics Based on Force / RGB-D Feedback

Panagiotis N. Koustoumpardis, Konstantinos I. Chatzilygeroudis, Aris I. Synodinos, Nikos A. Aspragathos

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In this paper, the collaboration of a human and a robot for executing complicated handling tasks for folding non-rigid objects is investigated. A hierarchical control system is developed for the task of co-manipulation folding sheets like fabrics/cloths. The system is based on force and RGB-D feedback in both higher and lower control levels of the process. In the higher level, the perception of the human's intention is used for deciding the robot's action, then in the lower level the robot reacts to the force/RGB-D feedback to follow the human guidance. The proposed approach is tested for the folding of a rectangular piece of fabric. The experiments showed that the developed robotic system is capable to track the human's movement in order to help her/him to accomplish the folding co-manipulation task.

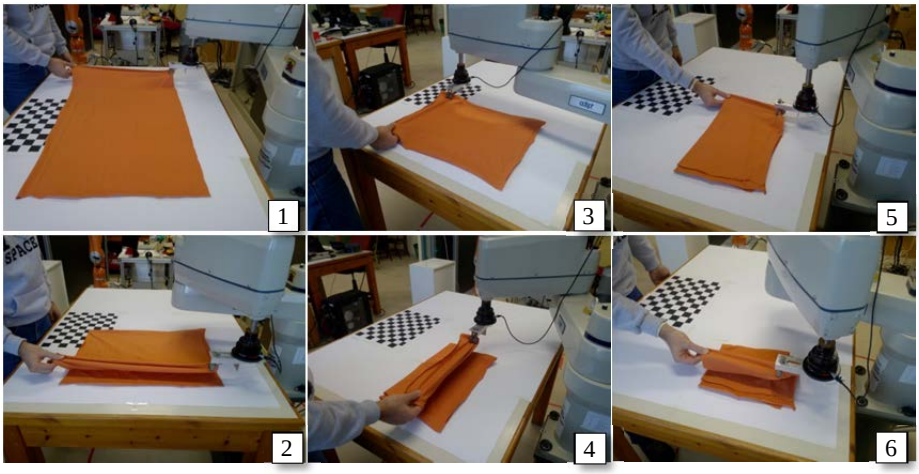

Fig. 1. Human robot collaboration for folding a fabric

Case Studies for Education in Robotics: From Serious Games to "Technology to Teach Technology" Platforms

Monica Drăgoicea and Theodor Borangiu

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The paper describes a specific perspective on developing case studies related to education in robotics. The proposed framework intends to support students to learn how to develop distributed software applications through functionality composition. The multi-agent approach is used as a test bed for case studies development. It tries to stress the role of the application development platform in creating rich simulations, giving students the possibility to express their goals with clarity, and creating suitable application architectures to achieve their goals. The presented roadmap describes three "Technology to Teach Technology" platforms supporting distributed application development. The last section of the paper gives the structure of a specific case study in mobile robotics, along with the Presage2 multi-agent platform. In Presage2, formal models of distributed information processing systems expressed as agent societies can be operationalized through simulation, while software components' interaction is supported by means of a powerful rule-based agent choreography mechanism.

With Presage2, case studies approaching education in robotics can be further designed to highlight specific educational principles to sustain the way future generations will approach real-world problems. The paper introduces a "virtual build and test" application development scenario, through which students may learn to include into the agent-based model a whole range of representations of surrounding reality. The development can be further guided following well defined mobile robotic use cases expressing self-organizing, coordination, cooperation and negotiation aspects where behavioural assemblages emulate a certain group dynamics like robotic foraging, robot soccer and formation maintenance.

Four main steps to follow when educational case studies in robotics are defined with Presage2 multi-agent programming platform are described, namely: (s1) robotic task identification; (s2) scenario definition; (s3) formal model design of the robotic task; and (s4) agent based operational modelling of the simulated robot assemblage society. Fulfilling these steps leads to the creation of specific outputs in terms of models and artefacts to be used later for action composition and task implementation on real mobile robots. Consequently, different design and development aspects can be expressed, such as: a) coordination of various robotic systems; b) experimentation within a simulated environment for coordinating the interactions of the different components of the multi robotics systems; c) modelling of the multi robotic system as a system of systems through the formal model design of the robotic task expressing coordination architectural styles; and d) developing a set of model architectures expressing distributed system design aspects, allowing students to observe global outcomes that are the consequence of agents' interactions and adaptation to specific governance rules.

Designing a Multimodal Human-Robot Interaction Interface for an Industrial Robot

Bogdan Mocan, Mircea Fulea and Stelian Brad

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This paper presents a framework for multimodal human-robot interaction. The proposed framework is intended to bring important contributions to the development of human robot interaction in order to facilitate intuitive programming and to enable easily adapting to changes in robot tasks without the need of using skilled personnel. The key elements of this system are speech and hand gesture recognition, text programming, and interaction capabilities that allow the user to take over the control of the robot at any given time. Furthermore, our approach is focused on robot tasks. A user can express his/her preference for one or more modalities of interaction so that selected modalities fit user's personal needs.

The proposed framework of multimodal interface reported in this paper is composed of four functional modules, as illustrated in Figure 1. The first module (multimodal interaction) translates hand gestures and voice command into a structured symbolic data stream. The second module (actions interpretation) selects the appropriate set of primitives based on the user input, current state, and robot sensor data. The third module (prioritized execution) selects and executes primitives based on the current state, sensor inputs, and the task given by the previous step. Finally, the fourth module facilitates the translation of the actions, voice command and gesture into instructions in robot native programming language to be integrated within a robot programming task.

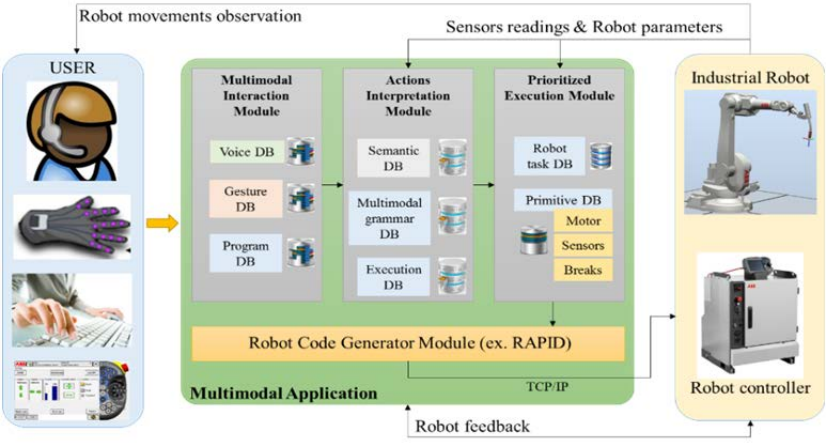

Fig. 1. The multimodal interface framework

Technical Session F:

Modelling and design of novel mechanisms and robotic structures

The Modelling of the Hexapod Mobile Robot Leg using Matlab SimMechanics

Sorin Mănoiu Olaru[1] and Mircea Nițulescu[2]

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In this paper the authors present a robot leg used to form a hexapod mobile robot structure. For this leg the direct kinematics, inverse kinematics and dynamic model were derived. The dynamic model was implemented using the SimMechanics toolbox from Matlab. The trajectory for the leg tip was implemented using a piecewise cubic spline interpolation method. All the algorithms, models and simulations were developed and tested using the Matlab software suite.

Also, in this paper examines the dynamic aspects of a hexapod robot leg that is used not only as support point but also as a mean of propelling the robot. From the dynamics analysis, the minimum torques required mainly in the femur and tibia joints where derived.

The movement of the leg tip along a predefined trajectory was done using a walking algorithm in which the dynamics analysis plays a major role. The control system of the robotic leg was experimented using Matlab and the Arduino Mega 2560 development board and will be improved in the future.

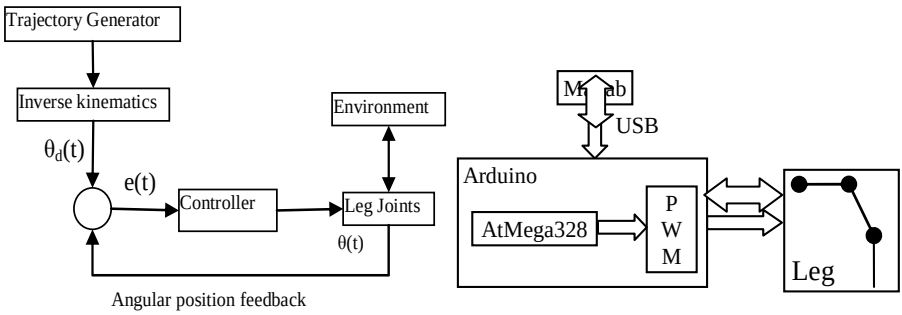

Fig. 1. Hexapod leg control diagram and experimental system

Static Analysis of Rotary Positioning Modules for Technological Head of the Robot

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The role of the actuator (drive) for a robot (machinery, equipment) is transferring execution power in a prescribed manner to the defined status of motion, so that the working mechanism can realize required positioning tasks (handling or technological) that operate with specified accuracy and speed. A suitable choice of actuators depends not only on their mechanical parameters, but also on the way the control and metering are exerted. Performance data of actuators from various manufacturers are comparable, the main difference resulting from their design. The reported research is a part of a project needing to design and implement accurate reducers and actuators in various modularized kinematic solutions. These modules can be combined and assembled into desired shapes with different sizes, which allows their deployment into production machines and robotic equipment according to specific customer requirements, e.g. technological heads. The paper presents FEM analysis modules, which are used for the design of technological heads for 2-axis handling and other robotic systems. These technological heads allow correcting inaccuracies in the motion of robot manipulators.

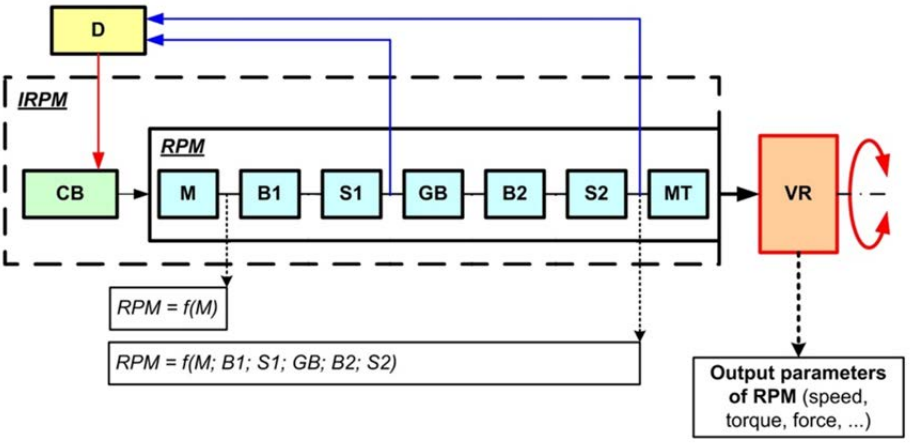

Fig. 1. Systemic RPM model – block structure

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Gibbs - Appell Equations of Motion for a Three Link Robot with Matlab

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The present study uses MATLAB as a tool to develop and solve the dynamical equations of motion for an open kinematic chain. MATLAB is convenient for finding the equations of motion using Lagrange method and for numerically solving the nonlinear differential equations. The study is based on a three-link robot. The kinematics model is developed based on generalized coordinates, angular velocities, and accelerations. The dynamic model is based on Gibbs – Appell equations of motion. In MATLAB the free variable x cannot be a function of time. In order to solve this problem, a function deriv was introduced. This function differentiates a symbolic expression f with respect to the variable g, where the variable g is a function of time g=g(t). Generalized active forces are defined and computed in MATLAB. For the direct dynamics the feedback control law are arbitrarily selected. The resulting system of equations of motion is solved numerically. Gibbs-Appell equations of motion are developed symbolically using MATLAB. The equations are solved numerically using matlabFunction and ode45.

Future research will focus on developing the proposed software for dynamic systems with multiple links and incorporating better numerical functions for solving the ordinary differential equations. Figure 1(a) shows the input generalized coordinates. The plots and the values of the external torques are shown in Figure 1(b).

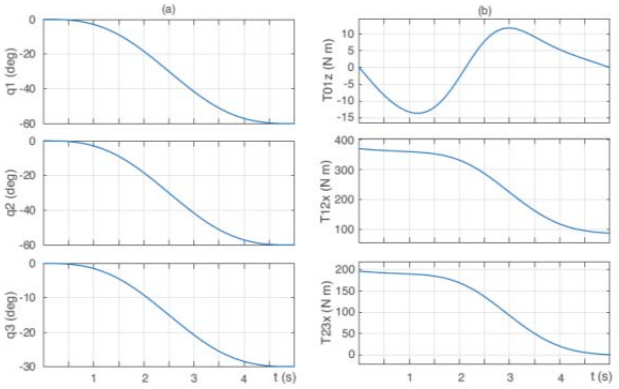

Fig. 1. Inverse dynamics: (a) input positions for the generalized coordinates and (b) calculated torques for input positions.

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A New Hyper-Redundant Arm and its Control System

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This paper presents a new physical hyper-redundant robotic arm structure and its sensorial, actuating and control systems. A system of cables actuated by DC motors is used for bending. The position of the robot can be obtained by bending it with cables and by blocking the position of the needed elements using an electro-pneumatic system. The major advantage of this type of actuation is that the robot can be actuated using a boundary control by cables with a single actuating unit, the position blocking system for any element being relatively simple. The main features and advantages of the sensorial system are presented in the paper. The second part of the paper describes the dynamical model of the arm based on Lagrange's formalism and the robot control based on the adaptive computed-torque method. Experimental results are analysed.

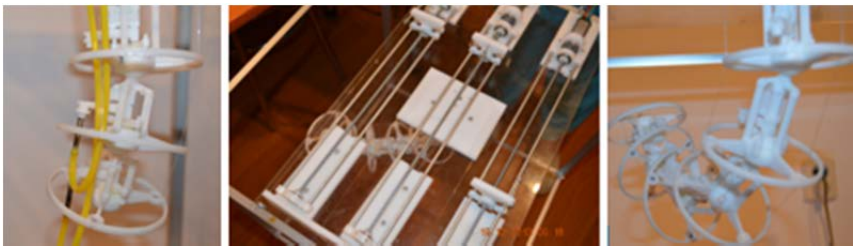

Fig. 1. The HHR hyper-redundant robot architecture

The combination of actuating cable with electro-pneumatically blocking system represents a new concept for hyper-redundant actuating. The sensorial systems have the possibility of measuring the 3D angular increments and joint errors, which allows closed loop positioning control.

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Dynamic Model of a Discrete Planar Tentacle Robot

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In this study, the dynamic model of a tentacle robot in two-dimensional space is presented. The technological model basis is an arm with a distributed mass. The 2D model basis from Fig 1 consists of a central, long and thin, highly flexible and incompressible backbone. It is made from homogeneous materials; the bending represents the main motion and the deformations of axial tension/compression and shear are neglected. The arm is divided in several segments, each segment having its own driving system. The motion of the arm - the bending is determined by the control of the fluid pressure and electro-rheological fluid viscosity. In order to develop the dynamic model of a hyper redundant planar robot, it will be considered a segment of the arm, for which the equivalent weight of the higher segments is denoted by M (Fig.1) with the mass uniformly distributed, with a linear density ρ, where ρ is the equivalent density of the composite materials and the electro-rheological fluid.

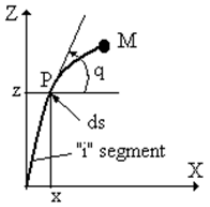

Fig. 1. Representation of *i*-segment of the arm

The paper describes the discretization of this type of robot, and then, by applying a nonlinear observer, proposes a control solution of the hyper redundant arm. Some results obtained by simulation of the robot's motion are presented and analysed.

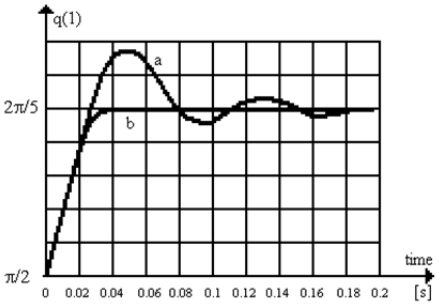

Fig. 2. The system's response to a gradual entry for different control laws:
(a) control without variable structure,
(b) control with variable structure

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How to Use 3D Printing for Feasibility Check of Mechanism Design

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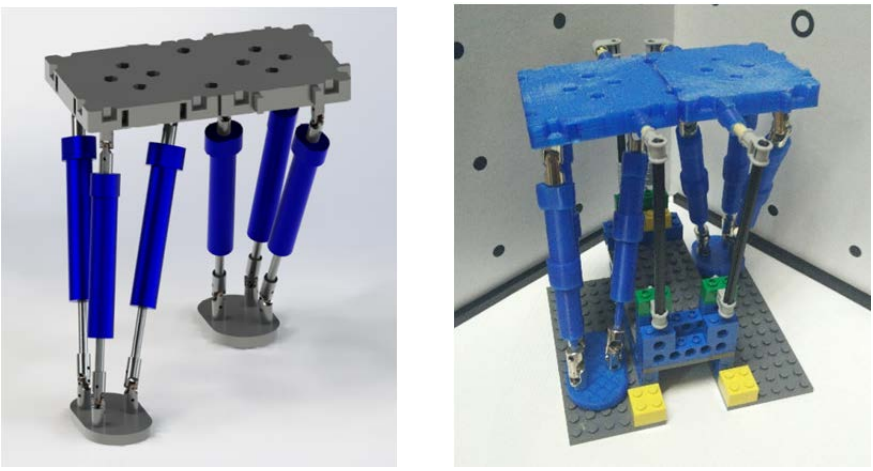
Prototype construction and validation testing is a fundamental activity in machine developments and particularly for robot designs. This activity is often time consuming and expensive, although necessary to achieve a proper final design. In recent years new solutions have been proposed and are available in the market with fairly cheap printers and procedures. Thus, Rapid Prototyping with 3D printing can be considered even at early stages of the product designs.

In this paper, 3D printing is presented as useful means for checking design feasibility of mechanism structures for robots. A procedure is outlined for rapid prototyping that can produce scaled prototypes for experimental validations since early stages of robot developments. Specific experiences at LARM are presented as related to ongoing development of LARM tripod Locomotor to show a practical convenience and soundness of using the proposed procedure of 3D printing prototyping for specific designs of mechanisms in humanoid robots, Fig.1.



(a) (b)

Fig. 1. The LARM Tripod Locomotor: (a) a 3D model in in SolidWorks® environment; (b) 3D printed model

Technical Session G:

Robots in medicine and rehabilitation

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Kinematic Behaviour of a Novel Medical Parallel Robot for Needle Placement

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The paper presents the kinematics of a novel parallel robot having applications in needle placement procedures. These kinds of procedures cover a large area of applications, like brachytherapy (BT), biopsy or fluid extraction. The main task of the robot consists in the following: the robot should insert rigid needles into the patient's body, having the diameter from 1.6 to 2 mm and lengths of 50 to 250 mm on a linear trajectory between the insertion point and the target point.

The authors have developed a 5-DOF parallel robot having a modular structure for the needle placement procedure. The robotic system consists of a parallel module with M=3 DOF (degrees of freedom) and three active joints (q_1, q_2, q_3), and a parallel module with M=2 DOF and two active joints (a planar mechanism with the active joints q_4, q_5) – Fig. 1. The inverse and direct kinematic models have been developed in the paper and some numerical simulation results are reported. A singularity-free reachable robot workspace has also been developed, for a given insertion point.

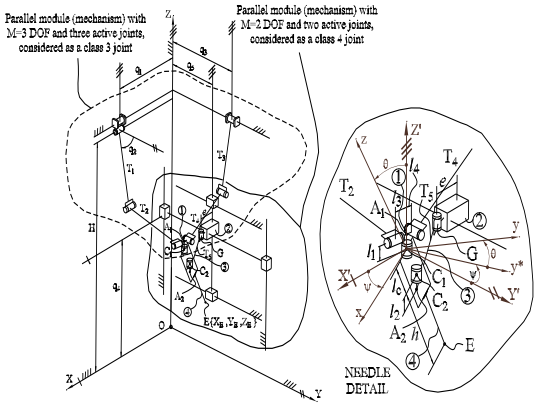

Fig. 1. The medical parallel robot – kinematic scheme

Optimal Planning of Needle Insertion for Robotic-assisted Prostate Biopsy

Doina Pîslă[1], Bogdan Gherman[1], Florin Gîrbacia[2], Calin Vaida[1], Silviu Butnariu[2], Teodora Gîrbacia[2] and Nicolae Plitea[1]

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Robotic systems used for prostate biopsy offer important advantages compared to the manual procedures. In the robotic assisted prostate biopsy procedure, an important problem is to identify the optimal needle trajectories that allow reaching the target tissue and avoiding contact with vital anatomical organs (major blood vessels, internal organs etc.).

The paper presents an algorithm for optimal planning of the biopsy needle trajectories, based on virtual reality technologies, using as case study a novel parallel robot designed for transperineal prostate biopsy.

The proposed planning algorithm calculates automatically, using VR techniques, optimal linear trajectories for the proposed transperineal prostate biopsy parallel robot with avoidance of high risk areas proximities. The developed algorithm has been tested in a virtual environment for the prostate biopsy robotic-assisted procedure, some results being presented in the paper.

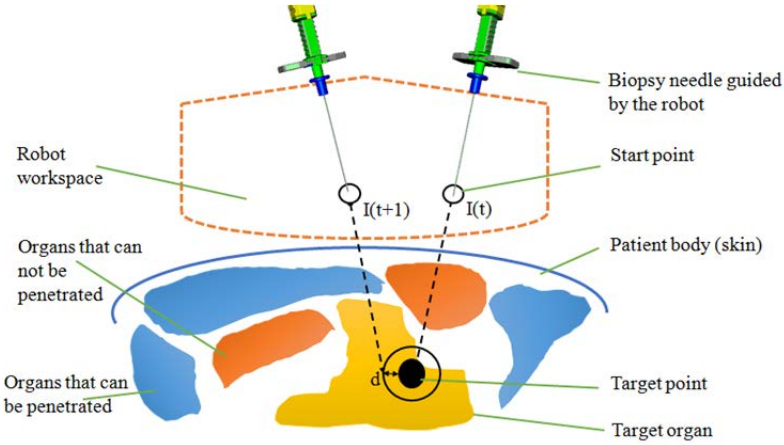

Fig. 1. Planning of biopsy needle trajectories

Towards Robot-Assisted Rehabilitation of Upper Limb Dysfunction

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This paper proposes a robot design which combines an unobtrusive presence around the household with a patient rehabilitation tool. The robot is envisaged to spend most of its time in standby mode, springing into action at pre-set times in order to engage the patient into taking a rehabilitation program. The rehabilitation tool guides the patient through a set series of prescribed repetitive physical exercises; it gives feedback and keeps track of the patient's progress, and summarises the feedback to a clinician who can supervise exercise uptake and effectiveness. The authors have achieved proof of this concept on two separate fronts which have been tested separately: an obstacle-avoidance robot which finds (and composes photographs of) people, and a stand-alone piece of software which displays and assesses physiotherapy exercises.

Fig. 1. Prototype photographer

Simulation and Control of a Robotic Device for Cardio-Circulatory Rehabilitation

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In immobilized patients like paraplegic subjects, due to absence of leg muscle contraction, venous return to the heart is reduced and this may induce important diseases to the cardio-circulatory system. The application to legs of a mechanical stimulation operated by an Intermittent Pneumatic Compression (IPC) device that replaces striate muscle pump on limb veins may recover venous return to the heart, thus restoring correct cardio-circulatory performance.

Figure 1 shows a prototype of IPC device and its basic functional scheme. It includes inflatable bladders (a) supported by shells (b), a pneumatic circuit with on/off electro-pneumatic valves for the air supply and a control unit for effective control of the inner pressure in bladders. The goal is to generate on the limb surface a peristaltic and centripetal pressure wave with proper pattern.

This paper deals with the study of an effective way to control such a device. Based on the numerical simulation of the human-machine system, the paper investigates and proposes an effective control solution.

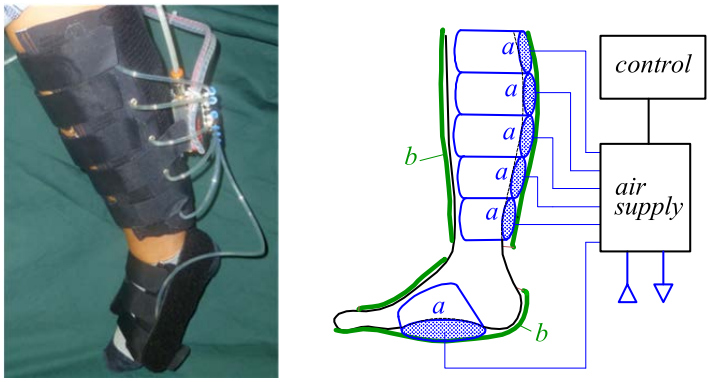

Fig. 1. Prototype of IPC device and its basic functional scheme

Technical Session H:

Tracking systems and Unmanned Aerial Vehicles

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Aiming Procedure for the Tracking System

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The tracking system monitors and recognizes several potential objects of interest. An operator selects an object for tracking. During the tracking mode the decision is made to initiate the procedure of aiming. Three measurements of the distance are used to establish motion parameters of the tracked object. The trajectory of the motion is calculated in order to specify the future hit point position. Finally, servos drive the system into the ballistic aiming position. To increase the hit probability, the whole tracking and aiming procedure is repeated automatically.

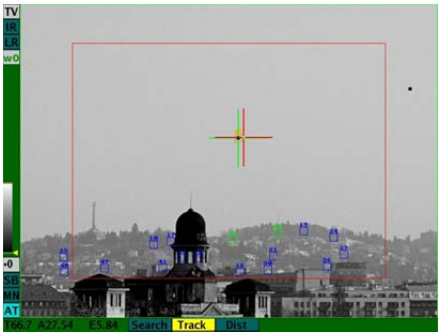

Fig. 1. Measuring the distance of the actual position (the green cross) using the predicted position (the red cross) during the tracking mode

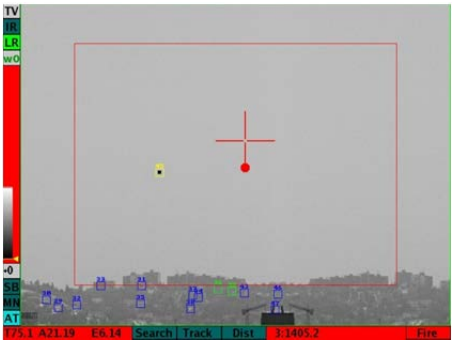

Fig. 2. Shot signaled by red strips on the left and below the picture. The aiming point (the red cross) and the predicted hit point (the red spot)

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Trajectory Generation with Way-Point Constraints for UAV Systems

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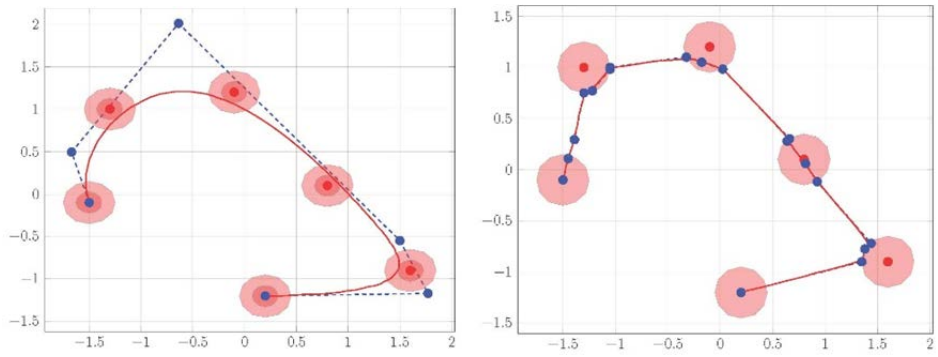
This paper addresses alternatives to classical trajectory generation for an unmanned aerial vehicle (UAV) which needs to pass through (or near) a priori given way-points. Using differential flatness for trajectory generation and B-splines for the flat output parameterization, the current study concentrates on flat descriptions which respect to UAV dynamics and verify way-point constraints.

Way-point relaxations (i.e., the UAV has to remain inside a neighborhood of the way-point for a predefined minimal time interval) are considered. To do so, we exploit geometric properties of the B-spline basis functions. The two directions followed are: i) impose more conservative constraints such that we guarantee the validation of the original constraints for a given time interval (Fig. 1a); and ii) design the B-spline curve such that inclusion in the way-point neighborhood is verified for a given time interval (Fig. 1b).



a) b)

Fig. 1. Flat trajectory with sensing regions and control polygon

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Kinematics-based Localization of a Skid-Steer Vehicle

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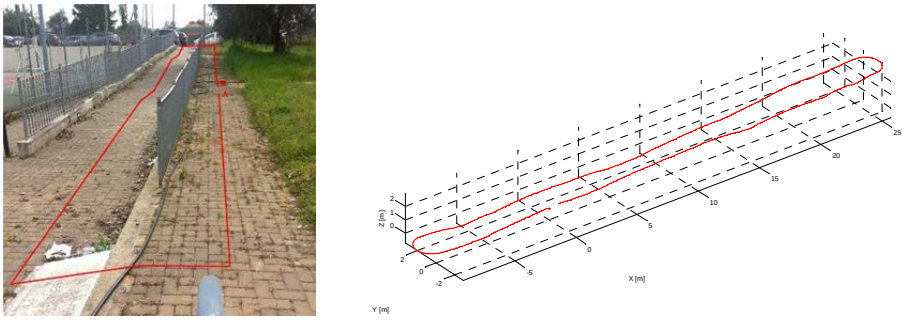
The paper addresses the localization issue for skid-steer vehicles. The large extent of slippage incurred by this type of vehicle in a turn heavily degrades the accuracy of their position estimation systems. Based on the kinematics modelling of skid-steering, the concept of equivalent track is presented. During field experiments using an off-road unmanned vehicle, this concept was shown to be effective in reducing localization errors up to two orders of magnitude.

This paper describes a method for localization of a skid-steer vehicle by using encoders and IMU sensors to define an equivalent track, in place of a fixed geometric track that can dynamically change depending on the interaction between the wheels and the terrain surface. Experimental results obtained from different paths were presented to validate the method showing its effectiveness to localize the vehicle along the path.

A test on an uneven surface is described in the paper (Fig. 1); the closed-loop rectangular trajectory (red line in Fig. 1(a)) covers routes having different height profiles. Nevertheless, the proposed strategy is able to reconstruct accurately the path (Fig. 1(b)) with a final error of 0.86% respect to the total length of about 70 m.



(a) Real path (b) Path reconstruction

Fig. 1. Test of the equivalent track method on an uneven surface

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Dynamic Task Planning of Aerial Robotic Platforms for Ground Sensor Data Collection and Processing

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The adoption of wireless sensor network systems is becoming wide-spread in critical large-scale monitoring applications. These include but are not limited to pipeline infrastructures for oil and water, border areas, roads and railway systems. In such scenarios, airborne robotic platforms like unmanned aerial vehicles (UAVs) can provide valuable services for data collection, communication relaying and higher level supervision. This is the case for both single UAV deployment as well as for swarms of UAVs collaboratively integrated into the monitoring system.

The paper discusses the opportunity for in-network pre-processing of sensor data for local UAV task planning in order to increase the efficiency of the data collection process. A gradient scheme is introduced for decision support of the UAV task planning. The results are validated by simulation.

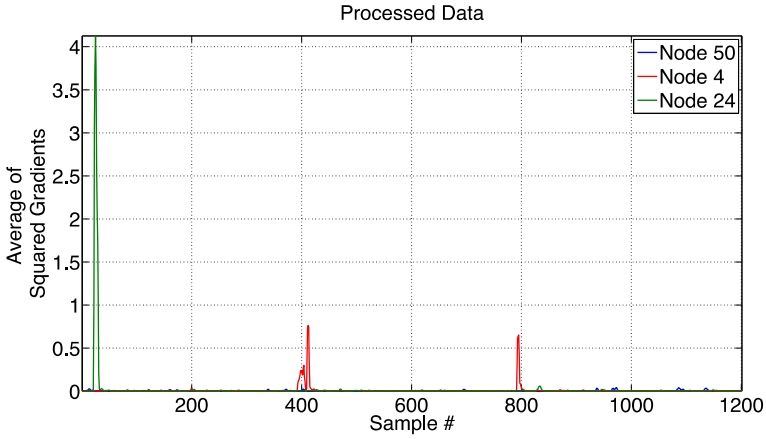

Fig. 1. Processing results for UAV task planning support

Improving Communication Efficiency of Hybrid UAV – WSN Systems

Maximilian Nicolae[1], Dan Popescu[1], Radu Dobrescu[1] and Cristian Mateescu[2]

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One of the well-known topics in wireless sensor networks (WSNs) is energy consumption efficiency in regard to communication needs. An unmanned aerial vehicle (UAV) that gathers data from a ground WSN can be seen as a gateway for the WSN. The paper presents a solution for improving the communication efficiency of a hybrid UAV-WSN system (Fig. 1) by using directional antenna and synchronization mechanism. The final goal is increasing the life of the ground nodes. The targeted architecture is described and some modelling assumptions are discussed. It is assumed that the UAV flies at a certain constant altitude H and with a constant speed *v*. The nodes are scattered at various 3D coordinates, having an arbitrary orientation (Fig.2 left). The radio coverage area for each node will be determined as the intersection between its antenna pattern and the flying plane (Fig.2 right). The calculus needed for modelling and simulation with visual representation was conceived in order to be implemented on the UAV-WSN hybrid system.

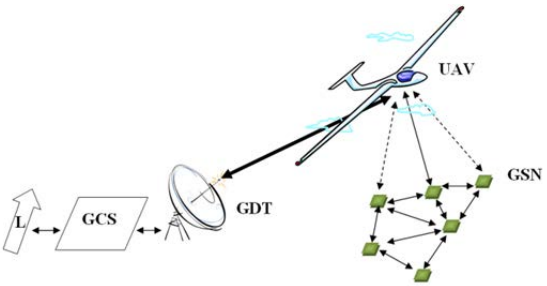

Fig. 1. Structure of the Hybrid UAV-WSN system

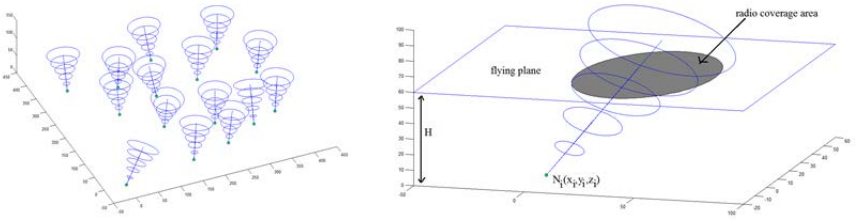

Fig. 2. The radio pattern model (left) and the radio coverage area (metric units scale)

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
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Top Viewing Human Tracking in Shopping Centers

Petros G. Vasileiou[1], Nefeli Lamprinou[1], Emmanouil Z. Psarakis[1],
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The problem of top viewing human tracking in a closed environment, such as is the area of a shopping center, is a challenging one. In this review paper we test a number of Kalman and simple particle filters-based techniques for solving the visual tracking problem. We present a system tailored for the top view human tracking inside the area of a shopping center. The surveillance cameras are typically mounted on the ceiling, more than three meters above the ground. This can be advantageous in discriminating separate humans within a crowd. The presented method aims at human tracking without using any personal information that could help distinguish one person from the other. However, because of this a one to one correspondence between a moving object and a path cannot be ensured.

As can be seen in the following figure (Fig. 1(a) shows one single object and Fig. 1(b) multiple moving objects), although the obtained results are promising and can be considered as adequate from all practical perspectives for the solution of problem at hand, more research must be done in order to allow the used filter to take into account the existing peculiarities in the movements of human beings.

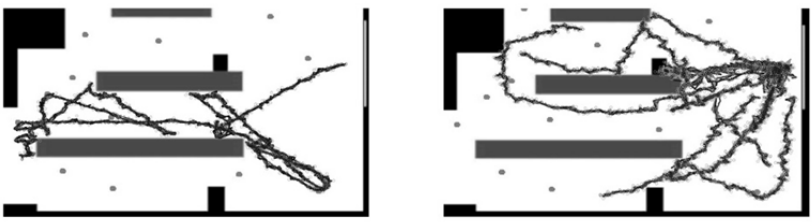

Fig. 1. Single (first image) and multiple (second image) people tracking results using the algorithms under comparison

Technical Session I:

Autonomous task learning, motion planning and scheduling

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Motion Planning and Scheduling with Stochastic Demands

Elias K. Xidias and Philip N. Azariadis

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This paper considers the combinatorial problem of motion planning and scheduling with stochastic demands. Here, an autonomous vehicle with limited capacity is requested to serve workstations in an industrial environment. Its workstation has a stochastic demand which is revealed upon the arrival of the vehicle. This combined problem is solved by optimizing the vehicle's schedule and route (minimum travel distance) under collision-free and vehicle-capacity constraints. An optimization strategy based on the combination of a genetic and micro-genetic algorithm is developed in order to determine the optimum solution. Experimental results demonstrate the effectiveness of the proposed approach.

Fig.1 presents an experiment where an autonomous vehicle with capacity $Q = 20$ is requested to deliver supplies to n = 8 workstations $ws_i, i = 1, \ldots, 9$ where ws_1 is the depot). The stochastic demand ξ_i follows a discrete probability distribution $\Pr ob(\xi_i = k),\ k = 1, \ldots, K \le Q$ (where $\xi_1 = 0$). In this test, we set $K = 4$.

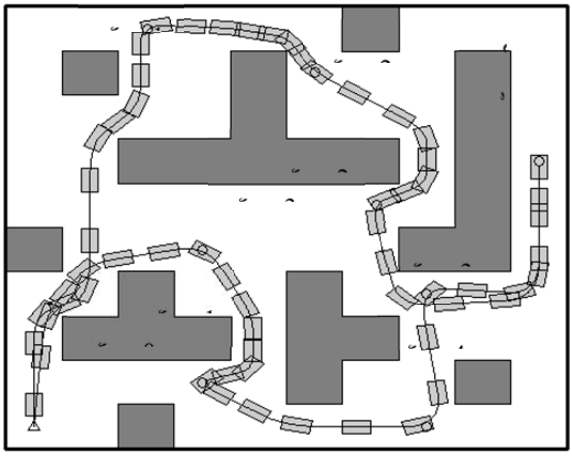

Fig. 1. The resulted "priori tour"

Abstracts of 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Autonomous Learning of Internal Dynamic Models for Reaching Task

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The paper addresses the problem of learning the internal task-specific dynamic models for a reaching task. Using the task-specific dynamic models is crucial for achieving both high tracking accuracy and a compliant behaviour, which improve the safety concerns while working in an unstructured environment or with humans. The proposed approach uses programming by demonstration to learn new task-related movements and encoded them as a Compliant Movement Primitives (CMPs). The CMPs are composed of a combination of the position trajectories encoded in a form of Dynamic Movement Primitives (DMPs) and the corresponding task-specific Torque Primitives (TPs) encoded as a linear combination of kernel functions. Unlike the DMPs, the TPs cannot be directly acquired from a user demonstration. Inspired by the human sensorimotor learning ability we propose a novel method which autonomously learns the task-specific TPs, based on a given kinematic trajectory in the DMPs.

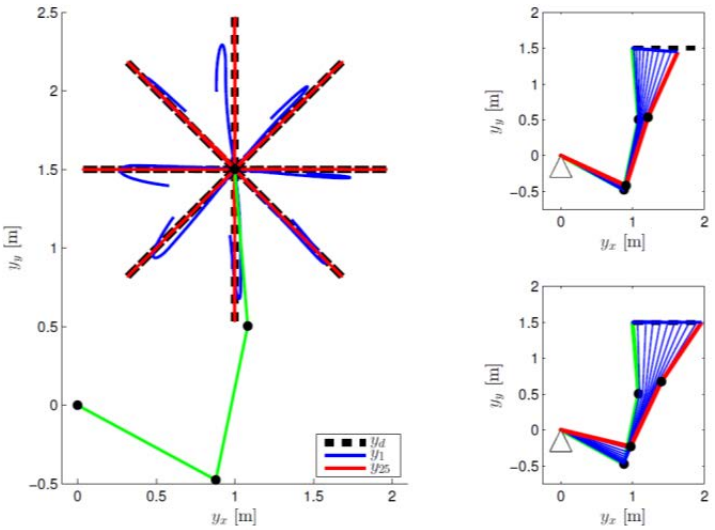

Fig. 1. Left hand side plot shows eight examples of the initial (blue) and the learned (red) robot behaviour in Cartesian space. Right hand side plots show the detailed example of the initial (top) and the learned (bottom) robot behaviour.

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Adaptation of Motor Primitives to the Environment through Learning and Statistical Generalization

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In this paper we propose a method of adapting motion to the environment based on force feedback. The method described combines two approaches of motor primitives' adaptation.

Starting from a single demonstration of motion, iterative learning control is used to adapt the motion to different conditions of the environment, such as the height of the table. The adaptation is implemented through coupling terms at the velocity level of a dynamic movement primitive, and acts as a feedforward component, predetermined for given external condition. As adaptation to each condition takes several iterations, we combine this method with statistical generalization, employing Gaussian process regression. By generating a small database of coupling terms through iterative learning, the environment is adapted by generalizing between the coupling terms in the database; this leads either to achieving an appropriate coupling term for the demonstration trajectory or to providing an initial estimate for the adaptation. Consequently, the learning does not need to be executed for every condition of the environment, but only for a small set.

The paper provides details of the method and evaluates it in a simulated setting for the use case of placing a glass on a table.

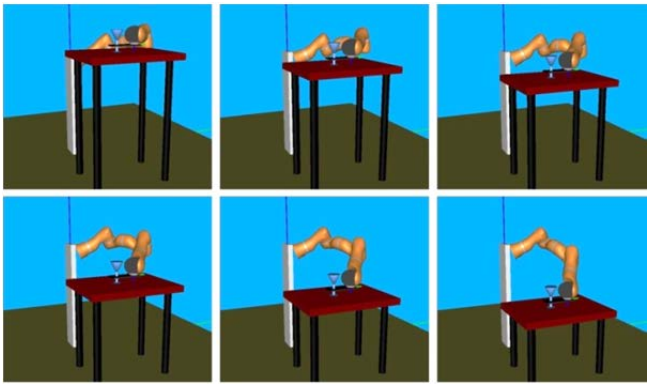

Fig. 1. Simulation of placing a glass on a table at different heights with the KUKA LWR robot

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Extended Kalman Filter (EKF)-based Local SLAM in Dynamic Environments: A Framework

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In the domain of mobile robots local maps of environments are used as knowledge base for decisions allowing reactive control in order to prevent collisions by following a global trajectory. These maps are normally discrete and updated with a relatively high frequency, but with no dynamic information.

The proposed framework (Fig. 1 left) uses a sparse description of clustered scan points from a laser range scanner. These features and the system odometry are used to predict the agent ego motion as well as feature motion using an Extended Kalman Filter. This approach is similar to a Simultaneous Localization and Mapping (SLAM) algorithm but with low-constraint features. The presented local Simultaneous Localization and Mapping (LSLAM) approach creates a decision base, holding a dynamic description which relaxes the requirement of high update rates. Simulated results demonstrate environment classification and tracking non-trivial situations (Fig. 1 right) as well as self-pose correction in static and in dynamic environments.

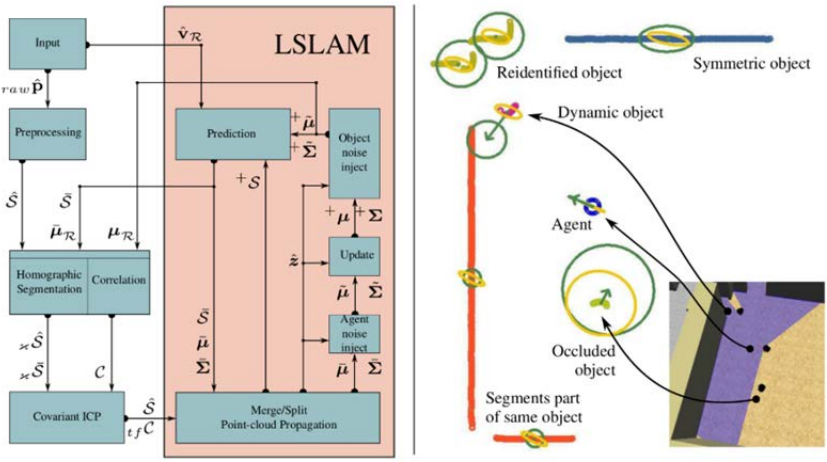

Fig. 1. Framework overview (left), Generated local map showcasing various non-trivial scenarios (right)

Abstracts of the 24th International Conference on Robotics in Alpe-Adria-Danube Region
May 27-29, 2015, Bucharest, Romania

Motion Analysis of a Robotic Wheelchair

Ionuţ Geonea and Nicolae Dumitru

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This paper presents the authors' contribution in designing a transmission system for a robotic wheelchair. The kinematics of the proposed transmission is analyzed in order to realize a proper synthesis of gears. A 3D model of the wheelchair with transmission is developed in Solid Works to be used for the dynamic simulation of the system in Adams software. The wheelchair motion simulation is made in Adams in two cases: traction motion and active steering motion. In case of traction motion simulation, the resulting motion trajectory is a straight line displacement and for the case when the steering motion is active, the resulting displacement trajectory is a circle. Simulation results demonstrate the efficiency of the transmission model and enable successful implementation of this design to a wheelchair model.

The wheelchair is still the best transportation means for disabled people, since its invention in 1595 (called invalids' chair) by an unknown inventor, for Phillip II of Spain. Wheelchairs have since then evolved into complex multiple degree-of-freedom mechanical and electro-mechanical devices and robotic systems. The research reported in the paper brings arguments for a mechanical transmission that realizes the differential movement for which the traction and steering components are controlled by separate motors achieving the proper angular speed difference of wheels. The model will be equipped with a motion controller that uses a pulse width modulated DC to DC converter (PWM).

The obtained 3D virtual prototype is very important because it will be used to simulate in Adams the wheelchair motion trajectory and study motion dynamics. The virtual prototype is useful in further design studies, such as weight minimization or ergonomic studies, to optimize the construction.

The paper offers a workspace analysis of the robotic system in Adams, for a combined trajectory composed by a straight line motion and steering. The wheelchair motion trajectory obtained is presented in Fig. 1.

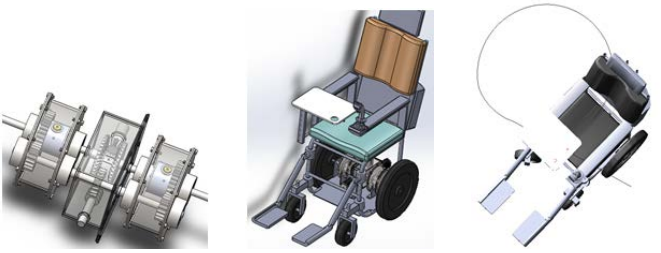

Fig. 1. Wheelchair transmission assembly and simulation

On Building Remotely Operated Underwater Robot-Explorer with Bi-Manual Poly-Articular System

Aleksandar Rodić, Ilija Stevanović, Miloš D Jovanović and Đorđe Urukalo

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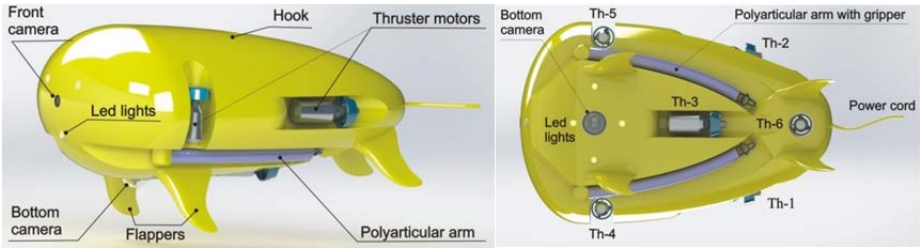
The paper presents the prototype development of a remotely operated vehicle (ROV) for underwater tasks. The development of the river underwater robot-grebe is intended for guided underwater search, underwater camera shooting, monitoring and inspection of objects submerged in the water, underwater installation, rescue missions, ecologic tasks, sampling of river bottom material and assistance in extraction of submerged objects from the river. The prototype of underwater robot-explorer is intended for utilisation in big and smooth (not turbulent, highland) rivers. The mechanical structure, rigid body dynamics, poly-articulated robot-arms, hydrodynamic characteristics, modelling and simulation are presented in the paper. Based on simulation of rigid body dynamics affected by water current, appropriate choice of thruster motors that power underwater robot is done. Some implementation aspects are considered based on the analysis of simulation results.



(a) (b)

Fig. 1. Underwater robot with its components (a-side view) (b-bottom view)

Recipients of past RAAD Awards

RAAD 2009 Workshop, Braşov, May 25 –27, 2009

Best Research Paper Award RAAD 2009

Recipients: Belfiore Nicola Pio, Verotti Matteo and Consorti Luciano from Italy

Paper Title: Comparative Analysis of Isotropy Indices in RR and RRP Arms

Abstract: In this paper isotropy and manipulability in RR dyads and RRP arms are analyzed and the solutions are obtained in algebraic symbolic forms. Such analysis is performed by means of two different methods: the classical approach based on the condition number and the Lie product. Although both the methods are known since decades, an accurate comparison of the two approaches has never been presented in literature. In particular, the geometrical interpretation of the Lie Product allows appreciating some interesting differences between the two methods.

Best Application Paper Award RAAD 2009

Recipients: Čepon Peter, Kamnik Roman, Kuželički Jernej, Bajd Tadej and Munih Marko from Slovenia

Paper Title: Experimental Mobile Robotic Platform

Abstract: Paper presents an experimental mobile robotic platform aimed at user friendly development of new mobile robotics applications. The development system incorporates the mobile platform construction, the drive unit with traction and steering wheel, main controller, the drive controller and the software development environment. The embedded controller running under xPC Target real time operating system is implemented in mobile platform. The controller controls drive units via CAN communication. The system enables software development and robot control on a remote host supervisory computer. The development system is based on Mathworks Matlab tools Simulink, Stateflow and xPC Target. This configuration allows the development of control algorithm in graphical mode by building and connecting functional blocks. In this way the development system is built providing user friendly graphical software development environment, optimal tuning of parameters, acquisition and logging of signals, and easy incorporation of new devices.

Best Student Paper Award RAAD 2009

Recipients: Borangiu Theodor, Dogar Anamaria and Dumitrache Alexandru from Romania

Paper Title: Calibration of Wrist-Mounted Profile Laser Scanning Probe using a Tool Transformation Approach

Abstract: This paper describes a method for calibrating a 3D laser scanning device mounted on the wrist of a 6-DOF robot arm, by computing a tool transformation for

the laser sensor reference frame. The calibration procedure involves scanning a spherical object fixed in the robot workspace, and it makes possible aligning many individual scans taken from different orientations. Another advantage of this approach is that further applications are made possible, such as using the laser sensor for accurate robot guidance and alignment.

RAAD 2010 Workshop, Budapest, June 23 –25, 2010

Best Research Paper Award RAAD 2010

Recipients: Gams Andrej, Petrič Tadej, Žlajpah Leon and Ude Aleš from Slovenia

Paper Title: Optimizing parameters of trajectory representation for movement generalization: robotic throwing

Abstract: For effective use of learning by imitation with a robot, it is necessary that the robot can adapt to the current state of the external world. This paper describes an optimization approach that enables the generation of a new motion trajectory, which accomplishes the task in a given situation, based on a library of example movements. New movements are generated by applying statistical methods, where the current state of the world is utilized as query into the library. Dynamic movement primitives are employed as the underlying motor representation. The main contribution of this paper is the optimization of dynamic movement primitives with respect to the kernel function positions and over the entire set of demonstrated movements. We applied the algorithm to a robotic throwing task, where the location of the target is determined by a stereo vision system, which can detect infrared markers. The vision system uses two Nintendo WIIMOTEs for cameras.

Best Application Paper Award RAAD 2010

Recipients: Bertetto Andrea Manuello,Falchi Costantino, Pinna Rinaldo and Roberto Ricciu from Italy

Paper Title: An Integrated Device for Saffron Flowers Detaching and Harvesting

Abstract: This work is concerned with a mechanical system designed to harvest Crocus Sativus (saffron) flowers. The system is conceived as a shoulder portable device with two main parts: the first one is specifically designed to detach the flower containing three stigmas, which are the costly final product; the second one is aimed to collect the detached flower through a vacuum collector. This paper describes the operating principle of the detaching and of the harvesting devices. The former device imitates one of the procedures followed by the pickers but with the peculiarity that allows to harvest the flower without separating it from its leaves, which is a significant advantage since it simplifies the mechanical detachment of the flower. The paper also deals with some experimental tests in the laboratory carried out in order to highlight the dynamic behaviour of the detaching and of the harvesting devices.

Best Student Paper Award RAAD 2010

Recipients: Sula Stanislav, Carbone Giuseppe and Pisla Doina from Romania and Italy

Paper Title: An Experimental Evaluation of Earthquake Effects on Mechanism Operation

Abstract: The results of successful experiments for investigating the earthquake effects on mechanism operation by using Cassino Parallel Manipulator (CaPaMan) as an earthquake simulator are presented. The experimental tests have been carried on by using a slider-crank and a four bar linkage as representing machine operations. The mechanism behavior has been experienced as strongly influenced when the mechanism motion has low speed as compared to earthquake disturbances. But even at high speed mechanisms are affected by the variable earthquake frequency.

RAAD 2012 Workshop, Naples, September 10 –13, 2012

Best Research Paper Award RAAD 2012

Recipients: Silvia Anton, Irina Mocanu, Florin Daniel Anton, Theodor Borangiu and Marco Ceccarelli from Romania and Italy

Paper Title: Gesture Recognition for Robot Assistance in Ambient Assisted Living Environments

Abstract: The paper presents a model for pattern discovery of human body posture and gesture interpretation. The model will be used in an ambient intelligent system, called AmIHomCare. The AmIHomCare system is an intelligent ambient system which performs home medical assistance of elderly or disabled people. One component of the AmIHomCare system performs daily activity recognition and monitoring. Each activity is viewed as a sequence of sub-activities. Each sub-activity is composed of a pair of person context (location in the room) and person body posture. The posture of the person is then considered as a full body gesture. The body gesture is detected by using a model for pattern discovering using decision trees. The proposed model allows the detection and interpretation of human static and dynamic gestures. Next, the human gestures will be associated with response actions executed by an assistant robot which will improve the quality of life of the assisted person.

Best Application Paper Award RAAD 2012

Recipients: Mario Donnici, Giorgia Lupinacci, Paola Nudo, Michele Perrelli, Sebastiano Meduri, Basilio Sinopoli, Diego Pulice, Calogero Pace and Guido Danieli from Italy

Paper Title: Navi-Robot in Conjunction with CT equipment to Guide Precision Biopsies

Abstract: This paper presents the first in vitro use of Navi-Robot to guide precision biopsies, after identification of the region to be sampled from the analysis of CT scan data. Before introducing the patient into the CT ring, three small plastic disks of a determined thickness are secured horizontally with tape on the patient's skin, two on the shoulders and one in correspondence to the iliac crest prominence, since these

points have minimal if no motion during breathing. Then, while the doctor examines the result, software, of which a first edition has been already developed, locates automatically the position of the disks in the CT coordinates system, thus establishing the base for a common frame of reference. Once the doctor decides the region to be sampled, eventually fixing also the direction of penetration, these data are supplied to the Navi-Robot, together with the disks coordinates in the CT coordinate systems. At this point, with the patient still on the CT stretcher, and Navi-Robot in navigation mode, the tip of the end effector is brought into contact with the centre of the three disks, and the new position to be assumed by the end effector is computed. Finally, passing to robot mode, the requested position is assumed, while the depth of penetration is also supplied.

Best Student Paper Award RAAD 2012

Recipients: Luka Peternel and Jan Babič from Slovenia

Paper Title: Using Human Sensorimotor Ability to Control Robot Stability: Construction and Evaluation of Human-Robot Interface

Abstract: Humanoid robotics has been a subject of many studies in the past years. The humanoid robots are to imitate the human body, characteristics and behaviour. Humans are extremely adaptable and are able to learn many things throughout their life. Our motivation is to exploit this ability to teach robots. If we want to teach a robot how to perform a certain task we need to adapt to the robot dynamics by controlling it with our own body. It is crucial that the robot remains stable at all times. Therefore the human needs to maintain its stability. Robot stability is related to its centre-of-mass (COM) position. In order for human to be able to keep the robot stable while performing and teaching it a certain task, he needs effective feedback information. We decided to use tactile, vestibular and proprioceptive feedback by exerting a force on a human operator at the point of his COM position. To achieve this, we developed a special haptic interface and tested if it is possible to effectively use it to maintain robot stability.

RAAD 2013 Workshop, Portorož, September 11 –13, 2013

Best Research Paper Award RAAD 2013

Recipients: Ugur Emre, Nagai Yukie and Oztop Erhan from Austria, Japan and Turkey

Paper Title: Parental scaffolding as a bootstrapping mechanism for learning grasp affordances and imitation skills

Abstract: Parental scaffolding is an important mechanism utilized by infants during their development. Infants, for example, pay stronger attention to the features of objects highlighted by parents and learn the way of manipulating an object while being supported by parents. Parents are known to make modifications in infant

directed actions, i.e. use “motionese”. Motionese is characterized by higher range and simplicity of motion, more pauses between motion segments, higher repetitiveness of demonstration, and more frequent social signals to an infant. In this paper, we extend our previously developed affordances framework to enable the robot to benefit from parental scaffolding and motionese. First, we present our results on how parental scaffolding can be used to guide the robot and modify robot’s crude action execution to speed up learning of complex actions such as grasping. For this purpose, we realize the interactive nature of a human caregiver-infant skill transfer scenario on the robot. During reach and grasp attempts, the movement of the robot hand are modified by the human caregiver’s physical interaction to enable successful grasping. Next, we discuss how parental scaffolding can be used in speeding up imitation learning. The system describes how our robot, by using previously learned affordance prediction mechanisms, can go beyond simple goal-level imitation and become a better imitator using infant-directed modifications of parents.

Best Application Paper Award RAAD 2013

Recipients: Sfakiotakis Michael, Arapis Manolis, Spyridakis Nektarios and John Fasoulas from Greece

Paper Title: Development and Experimental Evaluation of an Undulatory Fin Prototype

Abstract: Bio-inspired trusted designs encompass significant potential for developing a new generation of underwater vehicles with enhanced propulsion and maneuvering abilities, to address the needs of a growing number of underwater applications. Undulatory fin propulsion, inspired by the locomotion of cuttlefish and of certain electric eel species, is one such approach currently under investigation. Within this framework, we present the design and experimental evaluation of an undulatory fin prototype, comprised of eight actively controlled fin rays, which are interconnected by a flexible membrane. A control architecture, based on an artificial Central Pattern Generator (CPG), is used to produce the rays’ motion pattern associated with the undulatory movement of the fin. Experimental results from a parametric study indicate that the prototype can achieve speeds up to 1.45 fin lengths per second, and highlight the effect of the various kinematic parameters on the attained velocity and wave efficiency.

Best Student Paper Award RAAD 2013

Recipients: Cvišić Igor and Petrovič Ivan from Croatia

Paper Title: Inertial aided sensor platform stabilization for multirotor aerial vehicles

Abstract: Multiple rotor Unmanned Aerial Vehicles (UAVs) are becoming ubiquitous because of their construction simplicity and ease of maintenance. Such UAVs are able to hover, take off and land vertically. In addition, it is straightforward to design an on-board attitude autopilot. In comparison with classical helicopters, multi-rotor aircrafts

provide less dangerous tested in urban and cluttered environments due to their small-size and light-weight blades. In this paper, we present our prototype of aerial vehicle with eight rotors, which carry a unique platform for exteroceptive sensors. We designed inertial aided stabilization of the movement of the platform, decoupling the motion of exteroceptive sensors from the vehicle motion. This directly contributes to improved position and attitude estimation in visual navigation and smoother perception of the environment, and indirectly to achievement of the vehicle autonomy in urban and cluttered environments. The functionalities of the prototype aerial vehicle and the stabilizing platform are tested in simulation and experimentally.

RAAD 2014 Workshop, Smolenice, September 3 – 5, 2014

Best Theoretical Paper Award RAAD 2014

Recipients: Andrej Gams and Tadej Petril from Slovenia

Paper Title: Adapting periodic motion primitives to external feedback: modulating and changing the motion

Abstract: This paper evaluates the means of adapting periodic motions using either force or position feedback in order to permanently modify the motion, i.e. learn a new trajectory in order to comply with the conditions of the external environment. We evaluate three different approaches: a modulation approach using repetitive control, and two learning approaches of changing the motion. Simulation results have shown that all three approaches can be used with minor differences amongst them. Tests on a 7 degree-of-freedom Kuka LWR robot have shown that the approaches can be used in the real-world.

Best Application Paper Award RAAD 2014

Recipients: Mirko Rakovic. Marko Jovanovic, Branislav Borovac, Bojan Tepavl!evic, Milutin Nikolic and Mladen Papovic from Serbia

Paper Title: Design and Fabrication with Industrial Robot as Brick-laying tool and with Custom Script Utilization

Abstract: The paper presents methodology and implementation of parametric architectural design of brick-laying walls fabricated by industrial robotic arm. As a design tool Grasshopper is used, a visual programming editor that runs within the Rhinoceros 3D CAD application. Grasshopper offers a range of objects for creating parametric models including brick-laying walls. However it lacks the ability of integration with fabrication tools. To overcome this problem, a custom C# script has been developed. As the fabrication tool, the ABB-IRB 140 robotic arm is used. Thus the C# script is written in such a way to obtain the RAPID code for controlling ABB industrial robots. The C# script enabled automated generation of RAPID code in accordance to the Grasshopper generated geometries of walls.

Best Student Paper Award RAAD 2014

Recipients: Sromona Chatterjee, Timo Nachstedt, Florentin Wlirgotter, Minija Tamosiunaite, Poramate Manoonpong, Yoshihide Enomoto, Ryo Ariizumi and Fumitoshi Matsuno from Germany, Denmark and Japan

Paper Title: Reinforcement Learning Approach to Generate Goal-directed Locomotion of a Snake-Like Robot with Screw-Drive Units

Abstract: In this paper the authors apply a policy improvement algorithm called Policy Improvement with Path Integrals (PI) to generate goal-directed locomotion of a complex snake-like robot with screw-drive units. PI is numerically simple and has an ability to deal with high dimensional systems. Here, this approach is used as a model-free learning mechanism to find proper locomotion control parameters, like joint angles and screw drive velocities, of the robot for moving toward a given goal in a given time. Proper control parameters were also found when the robot was configured with different shapes and for different starting positions of the robot. The learning process was achieved using a simulated robot and the learned parameters were successfully transferred to the real one.

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The 24th International Conference on Robotics in Alpe-Adria-Danube Region, RAAD 2015, is held in Conference Centre of the Grand Hotel Continental, Bucharest, Romania, on May 27-29, 2015. The Conference brings together academic and industry researchers in robotics from the 11 Alpe-Adria-Danube Region affiliated countries (Austria, Croatia, Czech Republic, Germany, Greece, Hungary, Italy, Romania, Serbia, Slovakia and Slovenia), and their worldwide partners in a collegial and stimulating environment.

According to its tradition, RAAD 2015 covers all major areas of R&D and innovation in robotics, including new research trends such as: bio-inspired and cognitive robots, visual servoing of robot motion, human-robot interaction, and personal robots for ambient assisted living.

The conference topics address theoretical principles and methods, implementing solutions and tools for visual servo control of robot manipulators in grasping tasks. Guidance vision is presented as an advanced motion control method, which provides flexibility to robots integrated in manufacturing cells with unstructured environment and in line quality inspection, e.g. in the glass industry.

The Editors

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